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PHARMACODYNAMICS OF DATURA ALBA

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ONE PLATE

Datura alba Nees, or *talampunay*, is common throughout the Philippines. In and about Manila *Datura alba* Nees is the only species encountered. According to Merrill(9) it is not indigenous but of accidental introduction. The plant is widely distributed in tropical Asia, Africa, America, and Malaysia. In China and India it is employed as a medicine and as a poison. The Chinese frequently give the flowers mixed with food or in tea. Ford and Crow(6) and Mukopadya(10) reported several cases of *Datura* poisoning in China and India, respectively. In the Philippines, Bowman(2) reported a case of severe *Datura alba* poisoning in a chemist of the Bureau of Science. The chemist, while conducting experiments with *Datura alba*, ate approximately a gram of the seeds. One hour later, the following symptoms were observed: Dryness of the mouth, mydriasis, rapid pulse, flushed face, restlessness, laughing most of the time, scanning speech, and inability to form connected sentences. Later he became drowsy, fell asleep, and did not awaken until the next morning. On awakening, he seemed to be quite well, except for slight general weakness, mydriasis, and trouble in completing his sentences. Tavera's(13) description of the symptoms of *Datura* poisoning is practically identical. We have carried out the experiments detailed below in order to study the effects of the drug on animals, as well as its manner of action.

PREPARATIONS EMPLOYED

We employed alcoholic and aqueous preparations. The former was kindly given to us by Dr. P. Valenzuela, of the School of Pharmacy, University of the Philippines. It was prepared by him from the pulverized mature seeds of the plant, in accordance with the processes prescribed in the ninth decennial revision of the United States Pharmacopœia for the preparation of the fluidextract of belladonna, except that the last percolate was evaporated at 35° to 40° C. under low pressure. The latter was prepared as follows: Twenty mils of the alcoholic preparation were made alkaline by the addition of about 1 mil of 10 per cent ammonia, and then 30 mils of chloroform were added, and the mixture was shaken continuously for ten minutes. The mixture was allowed to stand in a separatory funnel, and the chloroform layer at the bottom, amounting to 32 mils, was removed. This was acidified by the addition of about 2 mils of dilute sulphuric acid and then 16 mils of water were added. This mixture was shaken continuously for ten minutes, allowed to stand in a separatory funnel, and the upper layer was taken off. The aqueous layer, after it was made neutral to litmus paper by the addition, drop by drop, of 10 per cent ammonia, amounted to approximately 21 mils. This aqueous solution was then allowed to evaporate in front of a rapidly revolving electric fan to 20 mils. The residue was slightly turbid and yellowish in color. The concentration of this aqueous preparation would be equal to the fluidextract if the active principles were completely extracted. We used this preparation in most of our experiments.

SYMPTOMS PRODUCED IN DOGS AND CATS

Hypodermic injection of 2 mils of the aqueous preparation per kilogram of weight of dog or cat chiefly affects the cerebrum, the respiration, the pupils, the pulse rate, and the secretion of tear and saliva. Within fifteen minutes after administration, the animal usually becomes restless and irritable when touched; the pupils dilate; the salivary secretion ceases; the respiration and the pulse are accelerated. The restlessness is followed by incoördination, then by sleep, and eventually by narcosis. The rate of the respiration is slowed as hypnosis sets in, but the mydriasis, dryness of the mouth and the conjunctiva, and rapid pulse persist even if the hypnosis lapses into narcosis. One of our protocols showing these different effects of *Datura alba* is given as Table 1.

TABLE 1.—*Symptoms produced by Datura alba in a male dog weighing 4.5 kilograms.*

[Date of experiment, January 25, 1921.]

Time.	Respiration per minute.	Pulse per minute.	Diameter of pupil.	Mucosa.			Remarks.
				Conjunctiva.	Lingual.	Nasal.	
a. m. p. m.			*mm.*				
9.48	30	90	4	Moist	Moist	Moist	Quiet.
9.53	30	84	4	do	do	do	Do.
10.02							Two mils of aqueous preparation per kilogram injected hypodermically.
10.04	32	168	12	Moist	Moist	Moist	Cried whenever touched.
10.09	42	168	12	do	do	do	Slightly restless.
10.14	50	186	12	Dry	Dry	Dry	Restless.
10.29	54	192	12	do	do	do	Ataxic gait.
10.50	48	186	12	do	do	do	Barked frequently; sought dark place.
11.00	42	168	12	do	do	do	Quiet; lying down.
11.15	30	144	12	do	do	do	Drowsy.
11.35	30	138	12	do	do	do	Asleep.
1.00	30	144	12	do	do	do	Stood with difficulty when made to do so; swayed to and fro and from side to side.
2.00	26	138	12	do	do	do	Fast asleep.
3.00	24	128	12	do	do	do	Do.
3.30	24	128	12	do	do	do	Unable to walk.

ACTION ON THE CIRCULATION AND RESPIRATION

We studied under this heading the effect of *Datura alba* on the heart rate, the blood pressure, and the respiration. The blood pressure was recorded with a mercury manometer; the respiratory movement with Gunn's stetograph,(7) and the heart rate with a tambour connected with blood-pressure connection. Table 2 records the result of one experiment on a dog weighing 6.7 kilograms, which was anæsthetized with morphine and chloretone.

Table 2 shows that soon after intravenous injection of the aqueous *Datura alba* preparation the heart rate was increased

from 142 to 217 per minute. This gradually decreased, becoming nearly normal one hour after injection. The blood pressure rose slightly, while the pulse pressure was markedly diminished. As the heart rate was returning to normal the pulse pressure gradually increased, with a tendency to return to the normal condition. The respiration showed slight if any change in rate and depth.

TABLE 2.—*Effect of Datura alba on the circulatory and respiratory systems of a dog weighing 6.7 kilograms.*

Time.	Procedure.	Blood pressure.			Heart rate per minute.	Respiration.	
		Systolic.	Diastolic.	Pulse.		Rate per minute.	Amplitude as recorded in tracing.
p. m.		*mm. Hg.*	*mm. Hg.*	*mm. Hg.*			*mm.*
1.27		78	72	6	142	27	3.5
1.28	0.015 mil *Datura alba* preparation injected intravenously.						
1.29		79	78	1	217	27	3.5
1.30		79	78	1	218	27	3.5
1.40		82	81	1	199	26	3.5
1.50		84	82	2	176	28	4.0
2.00		87	84	3	168	26	4.5
2.15		88	84	4	166	27	3.5
2.35		90	85	5	163	27	3.5

ACTION ON THE PUPILLARY REFLEX

We used cats in studying the action of *Datura alba* on the pupillary reflex. The diameter of both pupils was measured in dim light. Table 3 shows a typical result of our experiment.

As shown in Table 3 the mydriasis becomes maximal in twenty-five minutes after the application of the preparation. The pupil remained maximally dilated for twenty-four hours. Then it gradually returned to normal, complete recovery occurring in from five to eight days after application.

We tried to localize the seat of action of the preparation in accordance with the method described in Sollmann's Laboratory Guide.(11) A dog was anæsthetized with morphine and chloretone. The short ciliary nerves were isolated, and the corresponding vago-sympathetic was exposed and cut. Stimulation of the central end of the vago-sympathetic nerve caused dilation of the pupil, while stimulation of the short ciliary nerves produced constriction. An injection of 5 centimils of

the aqueous preparation into the anterior chamber of the eye caused almost immediate dilatation of the pupil. Full dilatation was reached one minute after injection. Stimulation of the central end of the vago-sympathetic caused further dilatation, while even maximal stimulation of the isolated short ciliary nerves was ineffective. Stimulation of the iris through the edges of the cornea was also ineffective. However, we failed to elicit any effect in either the normal or the atropinized eye with this method of stimulation.

TABLE 3.—*Effect of Datura alba on the pupil of a cat.*

[Date of experiment, November 17, 1920.]

Time.	Procedure.	Diameter of pupil.			
		Right.		Left.	
		Horizontal.	Vertical.	Horizontal.	Vertical.
p. m.		*mm.*	*mm.*	*mm.*	*mm.*
1.25		3	5	3	5
1.30		3	5	3	5
1.35		3	5	3	5
1.37	1 drop aqueous preparation applied in right eye				
1.42		3	5	3	5
1.47		3	5	3	5
1.52		6	8	3	5
1.57		9	10	3	5
2.02		10	10	3	5
3.02		10	10	3	5
4.00		10	10	3	5

The immediate response of the pupil to local application of the drug indicates that its site of action is most probably peripheral. The action may be either on the dilator or on the constrictor mechanism. The dilator mechanism was probably not affected for it still responded to electric stimulation even after the administration of large doses. On the other hand, the constrictor mechanism was paralyzed, for it no longer responded to electric stimulation after application of the drug. The iris muscles consist of dilator and sphincter, and, since both are smooth muscles, it may be expected that if one is paralyzed by direct action of the drug the other will be similarly affected. Paralysis of the dilator muscle was not present for it still responded to vago-sympathetic stimulation; hence it may be deduced that the sphincter was not paralyzed. The action may be localized on the oculomotor nerve fibers, on the nerve

ending, or at the hypothetical myoneural junction.(5, 12) We applied the drug on the fiber of the short ciliary nerve, but we have not succeeded in limiting it there. However, since in general the nerve endings are more susceptible to the action of drugs than are the nerve fibers, it is highly probable that *Datura alba* caused mydriasis by paralyzing the ending or the myoneural junction of the oculomotor nerve.

ACTION ON THE SALIVARY GLANDS

We used dogs in our experiments on the salivary glands. The animals were anæsthetized with morphine and chloretone. One femoral vein was connected with an injection burette. The chorda tympani and the salivary gland of one side were isolated and protected from exposure. The flow of saliva was recorded by a drop-recorder. Table 4 is an abbreviated protocol of one of our experiments.

TABLE 4.—*Action of Datura alba on the submaxillary gland.*

[Date of experiment, January 12, 1921.]

Time.	Procedure.	Amount of secretion per minute.	Remarks.
p. m.		*Drops.*	
2.40	Stimulation of chorda tympani	6	Saliva ceased after a few drops.
2.42	Stimulation of gland	4	Do.
2.50	2 decimils of 1 per cent pilocarpine were injected to increase flow of saliva.		
3.02		3	Saliva dropped continuously and tended to increase.
3.08	4 centimils of the preparation injected	0	Saliva flow ceased 30 seconds after injection.
3.10	Stimulation of gland	⅓	1 drop per 3 minutes.
3.15	Stimulation of chorda tympani	0	
3.21	Stimulation of gland	½	1 drop per 2 minutes.
3.24	4 decimils of 1 per cent pilocarpine were injected	0	
3.27	5 decimils of 1 per cent pilocarpine were injected	⅓	1 drop per 3 minutes.
3.36	Stimulation of gland	½	1 drop per 2 minutes.
3.38		1	
3.40	Stimulation of gland	2	
3.45	Stimulation of chorda tympani	1	No change in the rate of flow.
3.48	5 decimils of 1 per cent pilocarpine were injected	2	
3.55	Stimulation of chorda tympani	4	

Table 4 shows that 4 centimils of aqueous preparation of *Datura alba* seed easily overcome the action of 2 decimils of

1 per cent pilocarpine on the submaxillary gland. This quantity of the preparation of *Datura alba* did not paralyze the submaxillary gland, but abolished completely the response of the chorda tympani to electric stimulation. The quantity of pilocarpine which completely antagonized 4 centimils of the aqueous preparation of *Datura alba* was between 11 and 16 decimils of 1 per cent pilocarpine.

The cessation of salivary secretion after the administration of *Datura alba* may be attributed to one of two causes; namely, to paralysis of the chorda tympani or to paralysis of the secreting cells themselves. Since *Datura alba* stops the secretion of saliva caused by pilocarpine which stimulates the end of the chorda tympani, and since the gland cells are not paralyzed, *Datura alba* must act by paralyzing the end of the chorda tympani. Therefore, its manner of action on the salivary glands is identical with that of atropine and its allies.

ACTION ON THE INHIBITORY FUNCTION OF THE VAGUS NERVES

The action of *Datura alba* on the inhibitory function of the vagus nerves was studied in dogs. The animals were anæsthetized with morphine and chloretone, and prepared for blood-pressure tracing and for intravenous injection through the femoral vein. Both vagus nerves were cut, and the peripheral ends were prepared for electric stimulation. The response to induced current of the vagus nerves under the influence of large and small doses of the aqueous preparation was observed. The vagus nerves were paralyzed in one minute after an intravenous injection of 8 centimils, or 1.6 centimils per kilogram of body weight, of the aqueous preparation of *Datura alba*. The paralysis of the right vagus in one of our animals was complete for about twelve minutes. Then it gradually disappeared and complete recovery occurred one hour and seven minutes after the administration of the drug. At that time the left vagus had only slightly recovered.

The inhibitory power of the vagus is weakened by small doses of *Datura alba*. In one of our experiments, the effect occurred soon after the injection of 0.0005 mil of the aqueous preparation per kilogram of body weight and persisted for about ten minutes. The vagus nerve recovered completely in fourteen minutes. When the dose was repeated, depression of the vagus occurred again, but complete recovery of the nerve was prolonged to twenty-five minutes. With twice this dose, depression

was very marked and recovery occurred only twenty-five minutes after the injection. The recovery of the vagus nerve from the second injection of this larger dose was delayed to forty-two minutes.

ACTION ON THE ISOLATED INTESTINE

The action of *Datura alba* on the intestinal movements was studied by suspending a 2-centimeter piece of small intestine of cat in 30 mils of Ringer-Locke's solution contained in a muscle warmer. The muscle warmer was placed in a water bath which was kept at 38° to 40° C. The Ringer-Locke's solution was supplied with bubbles of oxygen throughout the experiment. One end of the intestine was fixed at the bottom of the solution, while the other end was attached to a heart lever for tracing. A rise in tracing indicates a contraction of the intestine while a lowering indicates relaxation. Plate 1, fig. 1, shows the record of one of our experiments.

The effect on the intestinal movement was not constant. With fresh intestine, contracting rhythmically, addition of *Datura alba* to the Ringer-Locke's solution generally produced relaxation and cessation of contraction. If the intestine was left in the solution, spontaneous and usually regular intestinal contraction appeared. An additional amount of *Datura alba* at this time did not alter the contraction. If, soon after cessation of intestinal movement, the solution was changed and contraction again established, the addition of pilocarpine produced relatively slight stimulation. Intestinal movement produced by pilocarpine was overcome by *Datura alba*. It is assumed that the site of action of pilocarpine in the intestine is the vagus ends. To counteract this effect of pilocarpine, *Datura alba* must paralyze either the ends of the vagus nerves in the intestine or the intestinal muscle, or must stimulate the sympathetic inhibitory mechanism. The muscle was not paralyzed, for it could still contract on mechanical stimulation.

STRENGTH OF THE PREPARATION

To determine the strength of *Datura alba*, we compared its effect on the inhibitory function of the right vagus nerve with the effect of atropine, of hyoscine, and of hyoscyamine. The vagus was stimulated with a Harvard inductorium whose secondary coil was set, throughout the experiment, at 6-centimeter distance. The results we obtained in this experiment are shown in Plate 1, fig. 2. According to this experiment 0.0005 mil of

the aqueous preparation of *Datura alba* is approximately equivalent to 0.0025 milligram of either atropine or hyoscine in depressing the vagus. Hyoscyamine is slightly weaker than *Datura alba,* hyoscine, or atropine. In other words, 1 mil of the aqueous preparation of *Datura alba* seeds is equivalent to 5 milligrams of either atropine or hyoscine. Since the aqueous preparation and the fluidextract were found, by biological assay, to be equal in strength, and 1 mil of fluidextract represents 1 gram of the seeds, therefore 5 milligrams of atropine or hyoscine are equivalent to 1 gram of *Datura alba* seeds; or, in other words, the alkaloidal content of *Datura alba* seeds is 0.5 per cent. This result is almost similar to the alkaloidal content found by Bacon(1) and by Brill(3) in air-dried seeds of the Philippine *Datura alba,* using the chemical method.

Browne,(4) working with flowers of the Chinese *Datura alba,* obtained 0.485 per cent of total alkaloids which he regarded as all hyoscine. Hesse(8) found, however, with flowers provided by Browne, 0.55 per cent of total alkaloids of which approximately 92 per cent was hyoscine, 6 per cent hyoscyamine, and 2 per cent atropine. We have not ascertained whether or not the preparation we used contained mostly hyoscine.

THERAPEUTIC DOSES

The therapeutic doses of *Datura alba* seed may be estimated from the alkaloidal content obtained, or from the dose required to depress or to paralyze the vagus inhibitory nerves. In the former case, if the alkaloidal content is 0.5 per cent and the predominating alkaloid is either hyoscine or atropine, whose pharmacopœial doses are from 0.3 to 0.6 milligram, the corresponding therapeutic doses of *Datura alba* seed would be approximately from 0.06 to 0.12 gram, and of the fluidextract from 1 to 2 drops. As to the latter we found that 0.001 mil of the aqueous preparation or 0.001 gram of *Datura alba* seed, per kilogram of body weight, depresses or nearly paralyzes the vagus inhibitory nerves. For an adult, weighing 60 kilograms, the therapeutic dose would be 0.06 gram. In either case, therefore, the therapeutic doses obtained by calculation are similar.

SUMMARY AND CONCLUSIONS

1. The effects of toxic doses of *Datura alba* in dogs and cats correspond to those produced in man. In large doses it produces excitement, then incoördination, and, lastly, depression with tendency to sleep.

2. The respiration was increased in dogs and cats after large doses, probably through stimulation of the respiratory center.

3. It dilates the pupils by peripheral action. The most probable action in this case is paralysis of the oculomotor nerve ending or its myoneural junction.

4. It stops the secretion of the submaxillary gland produced by pilocarpine. Since the glands were not paralyzed, the site of action must be either the nerve ending or the myoneural junction which is stimulated by pilocarpine.

5. The endings of the vagus nerves are depressed by small doses and completely paralyzed by slightly larger doses. The increased heart rate, slight rise of blood pressure, and decreased pulse pressure can be explained by diminished tonus of the vagus nerves.

6. It tends to stop intestinal contraction by peripheral action, for this was obtained in isolated intestine.

7. The alkaloidal content of *Datura alba* seeds as assayed biologically, using atropine or hyoscine as standard, is 0.5 per cent.

8. The tentative therapeutic doses of *Datura alba* seeds that may be recommended for man are from 0.06 to 0.12 gram and of the fluidextract from 1 to 2 drops.

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ILLUSTRATION

PLATE 1

FIG. 1. Normal contractions of isolated cat's intestine, augmented by the addition of 0.5 mil of 1 per cent pilocarpine, ceased after the addition of 0.05 mil of the aqueous preparation of *Datura alba*. The contractions returned soon after the solution was changed with fresh Ringer-Locke's solution. Additional amount of pilocarpine slightly increased the intestinal contractions.

2. Comparison of the effect of *Datura alba* on the vagus inhibition to the heart, with those of atropine and hyoscine. The use of 0.0025 milligram of atropine or hyoscine and 0.0005 mil of the aqueous preparation of *Datura alba* produced the same effect. B. P. indicates blood pressure; B. L., base line; S, stimulation of the right vagus nerve.

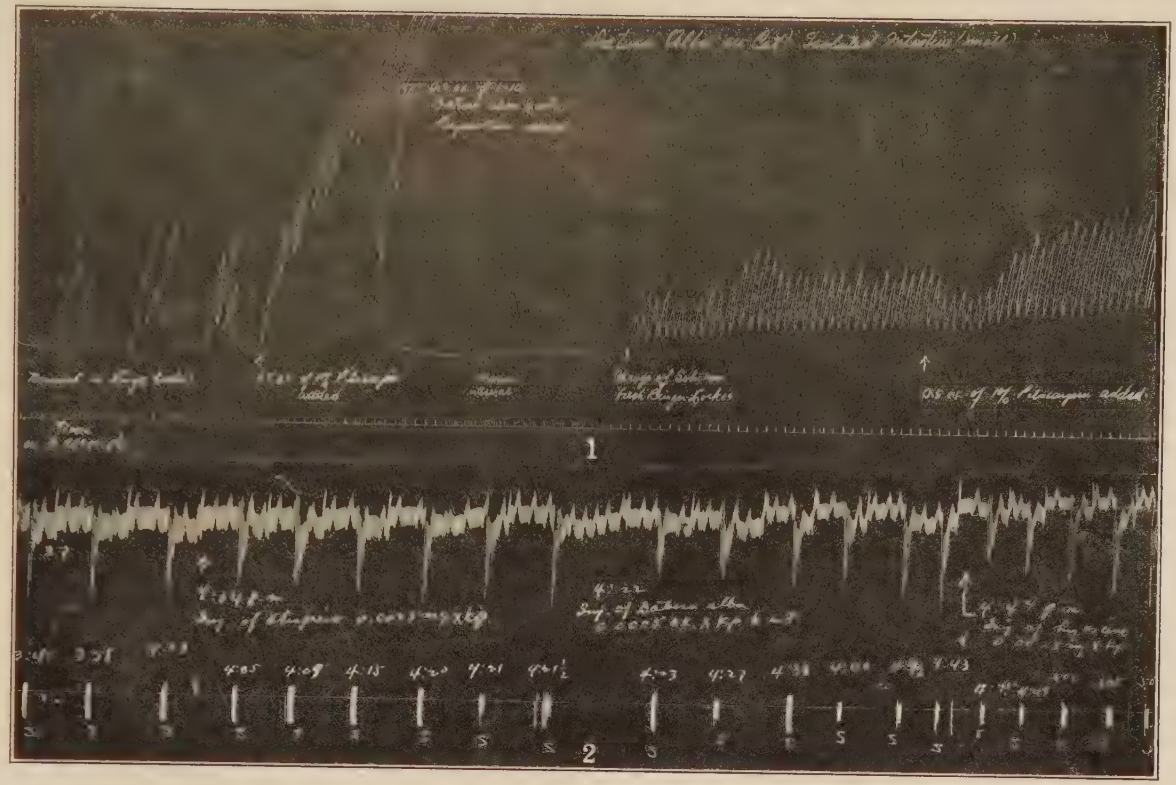

PLATE 1.

UNCOMMON INTESTINAL PARASITES OF MAN IN THE PHILIPPINE ISLANDS

REPORTS OF NEW CASES

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INTRODUCTION

Infestation of man with intestinal parasites is so prevalent in tropical countries that it is the absence rather than the presence of cysts and ova in stools that arouses attention. In the Philippien Islands the vast majority of the people, approximately 85 per cent, harbor one or more intestinal parasites. With few exceptions, the latter are species of protozoa and nematodes; in other words, parasites that are usually transmitted from host to host by means of polluted water, contaminated food, unclean hands, contact of the naked skin with soil infested with larvæ of parasites, etc. Intestinal parasites that are commonly encountered in Filipinos may be considered, therefore, an index to lack of sanitary conditions and to unhygienic habits.

In contrast to the almost universal occurrence in the Philippines of intestinal parasites in man that are conveyed from host to host directly through contact with cysts and ova is the rather uncommon occurrence of parasites that are conveyed from one person to another by intermediate hosts. Despite the surveys that have been made from time to time to determine the incidence of infestation of man in the Philippine Islands with intestinal parasites and the bearing of such parasitism on public health, comparatively few cases of infestation with flatworms have been recorded, and in nearly all instances the importance of cestode infestation in man and the possibility of transmitting these parasites to domestic animals with the

[1] Both authors assume responsibility for the new cases recorded in this paper; the senior author assumes full responsibility for the writing of the paper, for the review of the work of other investigators, and for the discussion of the significance of the several species of parasites that are considered in the paper.

resultant economic loss that such transmission involves have been almost entirely overlooked. As compared with protozoa and nematode infestations, flatworm infestations are so uncommon in the Philippines that physicians are apt to regard them as zoölogical curiosities rather than as problems worthy of serious consideration.

In the course of examinations of more than five hundred students of the University of the Philippines, between the ages of 20 and 30 years, representing nearly all provinces of the Philippine Islands, some flatworm infestations were discovered. In the following pages these cases are recorded, the published records of the same and closely related species of uncommon parasites are reviewed, and the significance of these cases of parasitism is discussed.

INFESTATION WITH TÆNIA

Three cases of infestation with *Tænia* were discovered in the course of the examinations referred to above. In one case gravid segments were obtained, which proved to be *Tænia saginata*. In the remaining two cases no segments were obtained, so that no specific determination could be made with certainty. In so far as measurements of ova are an index to specific identity, a diagnosis of *Tænia saginata* is warranted.

So far as concerns the frequency of *Tænia* in man in the Philippine Islands, Strong(13) records the results of about 1,800 stool examinations and 386 post-mortem examinations and states that only 2 adult *Tænia* were found. In the Annual Report of the Superintendent of Government Laboratories for the years 1902 to 1905(1) the results of 6,000 microscopic examinations of fæces are given and only 5 cases of cestode infections, namely *Tænia*, are recorded. Garrison(4) states that 26 of 28 specimens of *Tænia* from Filipinos proved to be *Tænia saginata*, the remaining 2 specimens being *Tænia solium*. The same author(5) records the results of over 4,000 stool examinations among which 30 cases of *Tænia* were found. Garrison and Llamas,(8) in a report on the results of examinations of 385 Filipino women and children for intestinal parasites, record 1 case of infestation with *Tænia*. Rissler and Gomez(12) report 8 cases of *Tænia saginata* infestation in 274 cases that were examined. In the same paper the authors refer to an unpublished case of *Tænia solium* in a Spaniard in Cagayan Valley. Chamberlain, Bloombergh, and Kilbourne(2) record 12 cases of *Tænia saginata* in 119 cases of examinations of Igorots

for intestinal parasites. They also refer to data collected in the Civil Hospital in Baguio, according to which 5 cases of infestation with *Tænia solium* and 4 cases of infestation with *Tænia saginata* were found in 183 examinations. Willets(16) records 59 cases of *Tænia* in over 4,000 fæcal examinations in tobacco haciendas in Cagayan Valley. Stitt(15) reports 3 cases of infestation with *Tænia saginata* in more than 900 examinations for intestinal parasites. Crowell and Hammack(3) report the results of 500 autopsies performed in the College of Medicine and Surgery in Manila and record but a single case of infestation with *Tænia saginata*. These authors state that but 1 case of *Tænia solium* was found in over 2,200 post-mortem examinations in the College of Medicine and Surgery. Crowell and Hammack refer to a case of *Cysticercus cellulosæ* in a Filipino, 28 years of age. This is apparently the first, and presumably the only, case of somatic tæniasis in man that has been recorded from the Philippine Islands. Willets(17) reports 1 case of *Tænia saginata*. The same writer(18) reports 57 cases of *Tænia* encountered in nearly 8,000 stool examinations, and Garcia(19) records 6 cases of *Tænia* in 1,600 stool examinations.

From the review of the literature with reference to infestation of man in the Philippines with *Tænia* it is evident that in the Philippines, as in other parts of the world, *Tænia saginata* is by far the commoner species and that *Tænia solium* is comparatively rare. In as much as the source of infection of human beings with *Tænia* is the flesh of cattle and hogs that is eaten without being cooked sufficiently to destroy tapeworm cysts, it follows that *Cysticercus bovis*, the larval stage of *Tænia saginata*, occurs in cattle and that *Cysticercus cellulosæ*, the larval stage of *Tænia solium*, occurs in hogs that are slaughtered in the Philippine Islands. As no data with regard to the extent of occurrence of cysticerci in cattle and hogs in the Philippines have been published, the senior author examined the files of the Bureau of Agriculture with a view of obtaining information on this point. The data presented in Table 1 were obtained through the courtesy of Dr. Stanton Youngberg, chief veterinarian of the Bureau of Agriculture.

Table 1 is based on the records obtained at the Azcarraga abattoir in Manila. The hogs in question are largely mestizos that are raised in the provinces under conditions that give them ready access to human fæces. Owing to the lack of privies in the provinces human fæces are generally devoured by hogs, thus favoring the perpetuation of *Tænia solium*.

TABLE 1.—*Showing the frequency of infestation of native hogs with Cysticercus cellulosæ.*

Year.	Hogs slaughtered.	Hogs infested.	Approximate infestation.
			Per cent.
1914	75,543	1,017	1.3
1915	84,736	1,275	1.5
1917	107,626	1,282	1.2
1918	108,145	1,275	1.1
1919	109,118	1,481	1.3
1920	109,662	1,123	1.0

From the data with reference to the occurrence of *Cysticercus cellulosæ* in native hogs, it will be seen that the degree of infestation with this parasite is comparatively high. In as much as pork infested with *Cysticercus cellulosæ* is regarded by public health authorities as unfit for human consumption, and since in countries where meat inspection is enforced carcasses infested with *Cysticercus cellulosæ* are generally condemned, unless the infestation is light, the economic loss sustained in the Philippines as a result of such infestation would be extremely high if meat-inspection laws were enforced throughout the Archipelago. It is greatly to be deplored that meat-inspection regulations for the safeguarding of human health are not enforced in the provinces of the Philippine Islands. While it is true that in the provinces more than 1 per cent of the hogs slaughtered are saved (?) from condemnation, it must be remembered that the provincial population is buying diseased meat that is not only objectionable from an æsthetic viewpoint but also dangerous to health. While Filipinos do not, as a rule, consume rare pork, the possibility of acquiring tapeworm infestation exists in the absence of enforcement of meat inspection. The fact that such infestations are actually acquired is evident from the undiminished source of infestation of hogs; namely, human fæces containing ova of *Tænia solium*.

Infection of man with *Tænia solium* is to be avoided not only because of the discomfort which it may cause and because of the possibility of passing the infection to hogs, due to the lack of privies, but also because *Cysticercus cellulosæ* is capable of developing in man and lodging in the brain, the eye, the muscular system, the heart, the subcutaneous connective tissue, the liver, the lungs, and other organs. One case of *Cysticercus cellulosæ*

infection in man has already been recorded in the Philippines, as noted elsewhere in this paper.

No data are available with regard to the occurrence of *Cysticercus bovis* in native cattle, because native cattle are seldom slaughtered in Manila abattoirs, and because in the provinces, where native cattle are killed for consumption, no meat-inspection service is maintained. Cattle slaughtered in Manila are usually imported from French Indo-China. These imported cattle are singularly free from *Cysticercus bovis*, as shown by the records of the Bureau of Agriculture for the years 1914 to 1920, exclusive of 1916, during which period only two cases of infestation with *Cysticercus bovis* were found in over 30,000 cattle examined post mortem for evidence of disease. According to Ransom(11) 1 per cent of all adult cattle slaughtered in the United States is infected with *Cysticercus bovis*.

INFESTATION WITH HYMENOLEPIS

One case of infestation with *Hymenolepis diminuta* was found in a male student, 20 years of age, from Samar Province; and, as will be shown presently, this is the first case of infestation with *Hymenolepis diminuta* in a Filipino that has ever been recorded. Cases of infestation with *Hymenolepis diminuta* in man are so rare the world over that reports of individual cases are warranted. A case from the United States and a review of all cases in that country recorded in the literature on parasitology have been recently published by Schwartz,(14) and several cases from the United States heretofore unpublished are to be found in that review.

Garrison(4) refers to a case of infection with *Hymenolepis diminuta* in a Chinese prisoner in Bilibid Prison, Manila. The same author(6) in a report on the prevalence of intestinal parasites in man in the Philippines, based on fæcal examinations of inmates of Bilibid Prison, refers to a case of infestation with *Hymenolepis diminuta* which is without question the same case as that recorded by Garrison in 1907(4) since the data published in 1908(5) are based on work performed in 1907 as stated by Garrison in the introduction to the former paper. The case of *Hymenolepis diminuta* that is recorded in this paper is, therefore, the first case of infestation with this parasite in a Filipino that has been recorded.

As is well known, *Hymenolepis diminuta* normally occurs in the small intestine of rats. Garrison(4) states that, in addition

to his material from the Chinese prisoner, the Bureau of Science collection contains two specimens of *Hymenolepis diminuta* from rats in Manila. One of us (Schwartz) has recently found many adult specimens of *Hymenolepis diminuta* in the intestines of house rats. About one dozen field rats have been examined thus far, and no adult tape worms have been found in them.

No case of infestation with *Hymenolepis nana* was found in the course of our examinations for evidence of parasitism. Garrison(4, 5) records 4 cases of infestation with this parasite. Rissler and Gomez(12) record 1 case of *Hymenolepis* infection, and Willets(16) records 5 cases; no specific determination is given in any of these papers. Willets(18) records 4 cases of *Hymenolepis* in nearly 8,000 stool examinations, and Garcia(19) reports 1 case in 1,600 examinations, but no specific determination is given by these writers.

INFESTATION WITH OTHER CESTODES

In addition to the species of cestodes that have been mentioned, Garrison(7) reports the presence of *Davainea madagascariensis* in an adult Filipino, the infestation having been discovered in the course of an autopsy. Mendoza-Guazon(10) records a case of *Dipylidium caninum* in a Filipino child, 8 months old, likewise discovered during an autopsy.

INFESTATION WITH TREMATODES

One case of *Clonorchis sinensis* infection was found in a Chinese student, 21 years of age. The Chinaman came from Canton, and had been living in the Islands several months when the infection was discovered. He showed no symptoms and did not complain, even after being questioned. A blood examination was made and the following results were obtained: Hæmoglobin, 90; total erythrocytes, 4,680,000; eosinophilia, 14 per cent.

Crowell and Hammack(3) in a report on intestinal parasites encountered in 500 autopsies record 2 cases of *Clonorchis sinensis* infestation in Chinese.

No additional records of *Clonorchis* infection in the Philippines have been found, and it may be concluded that this parasite has not yet been recorded from Filipinos. In view of the pathogenicity of this parasite, it is important that precautionary measures be taken to prevent the importation of *Clonorchis* infections to the Philippine Islands. It is uncertain, of course, that *Clonorchis* and other trematodes that occur in Chinese, Japanese, and other Orientals can be transmitted to new defini-

tive hosts in the Philippines because of the possible absence of intermediate hosts. In the absence of such knowledge precautionary measures are warranted, and Chinese, Japanese, and other immigrants arriving from countries where dangerous parasites of man are prevalent should be subjected to examination for parasites before being admitted to the Islands.

A case of infestation with *Echinostoma ilocanum* was found in a student, 22 years of age, a native of Zambales Province, Luzon. A second case of infestation with this parasite was found in a student, 23 years of age, from Ilocos Norte Province, northern Luzon.

This species, which has not been recorded outside of the Philippines, was first described by Garrison,(6) who found only 5 cases in about 5,000 fæcal examinations. All of Garrison's cases are individuals from northern Luzon. Willets(16) records a probable case of infestation with *Echinostoma ilocanum*, but makes no definite diagnosis. Hilario and Wharton(9) record 5 cases of infestation with this parasite, 4 of which are from Zambales Province; no data were given for the fifth case.

Nothing very definite is known concerning the possible pathogenicity of this parasite. Garrison's patients showed no symptoms and did not complain of feeling unwell. In the cases reported by Hilario and Wharton a slight anæmia was apparently present.

SUMMARY AND CONCLUSIONS

1. Three new cases of infestation with *Tænia* are recorded.

2. Data with reference to the occurrence of *Cysticercus cellulosæ* in native hogs show that from 1 to 1.5 per cent are infested.

3. A case of infestation with *Hymenolepis diminuta* is recorded. This is the first case in which this parasite has been reported from a Filipino and the second case that has been recorded from the Philippine Islands.

4. A case of *Clonorchis sinensis* is reported from a Chinese student. This is the third case that has been reported from the Philippines.

5. Two cases of infestation with *Echinostoma ilocanum*, a species apparently confined to Filipinos of northern Luzon, are reported.

6. To prevent infestation of man with *Tænia solium*, *Tænia saginata*, and *Cysticercus cellulosæ* and to eradicate infestation of hogs with *Cysticercus cellulosæ* and of cattle with *Cysticercus bovis*, as well as to safeguard the provincial population against

the consumption of diseased meats, extension of meat inspection to the provinces is recommended.

7. Routine examinations of immigrants arriving from ports where dangerous parasites of man are prevalent should be undertaken to prevent the introduction of such parasites into the Islands.

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NEW PARASITIC HYMENOPTERA FROM THE ORIENTAL ISLANDS

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TWO TEXT FIGURES

This paper contains descriptions of new diapriids, bethylids, and braconids from the Philippine Islands, Borneo, and Singapore. The specimens studied in writing the descriptions were sent to the United States National Museum by Prof. C. F. Baker.

Thanks are due and here recorded to Mr. S. A. Rohwer for permission to study Professor Baker's material, and to Miss Eleanor Armstrong for drawing the head of the new species *Loboscelidia maculipennis*. The other drawings were made by me.

DIAPRIIDÆ

Genus **LOBOSCELIDIA** Westwood

Westwood founded this genus on a single species, *L. rufescens* Westwood, from Sulu Island, southwest of Mindanao, Philippine Islands. Kieffer has described two new ones in his recent monograph of the family Diapriidæ.[1]

All the species, including those described in this paper, are from the islands southeast of Asia. *Loboscelidia defecta* Kieffer occurs both in Borneo and in Singapore if my identification is correct. Its type locality is Palawan Island of the Philippine group.

It seems probable that these wasps are myrmecophilous. They have somewhat the habitus of ants and the woolly appearance of the neck is characteristic of many myrmecophiles.

Key to the species of Loboscelidia Westwood.

Head in front with a hornlike projection..... **L. rufescens** Westwood.
Head in front without such a projection..... 1.

1. Basal nervure nearly absent, briefly indicated proximad.
L. bakeri sp. nov.

Basal nervure complete, distinct..... 2.

[1] Das Tierreich, Lief. 44 (1916) 14.

2. Body black; parapsidal grooves complete..... **L. nigra sp. nov.**
   Body rufous..... 3.
3. Face with a broad, circular, and shallow depression bordered by a sharp carina, the carina nearly touching the eye margin and the anterior ocellus..... **L. antennata sp. nov.**
   Face without an area inclosed by a carina..... 4.
4. Parapsidal grooves incomplete..... 5.
   Parapsidal grooves complete..... 8.
5. Basal nervure with a sharp bend at distal end. **L. philippinensis sp. nov.**
   Basal nervure not sharply bent at distal end..... 6.
6. Pronotum transverse..... 7.
   Pronotum a little longer than wide..... **L. inermis Kieffer.**
7. Face with an inconspicuous median furrow; wings conspicuously covered with brown spots and streaks..... **L. maculipennis sp. nov.**
   Face with a sharp median carina; each anterior wing with a yellowish band across its middle..... **L. carinata sp. nov.**
8. (4) Scutellum longitudinally striate or punctate..... 9.
   Scutellum polished, faintly shagreened or unsculptured..... 10.
9. Mesonotum shorter than the scutellum, its median lobe shagreened; membrane on hind tibia wider than the tibia itself.. **L. collaris sp. nov.**
   Mesonotum about as long as the scutellum, its median lobe polished. **L. scutellata sp. nov.**
10. Dorsal cervical plate highly arched, not concave..... **L. defecta Kieffer.**
    Dorsal cervical plate flattened, concave above..... **L. brunnea sp. nov.**

Loboscelidia bakeri sp. nov.

Male.—Length, 2 to 3 millimeters. Face flattened, smooth, finely shagreened, not carinate laterally, with a short median carina below, antennal ledge, seen from above, bilobed, emarginate medially, perpendicularly declivous in front, seen from the side without an inferior projection; dorsal cervical plate highly arched medially, quadrate, not excavated; cervical membrane just meeting, not overlapping, apparently without pubescence; antennæ as long as the body, slender, of an even thickness throughout; scape with a narrow membrane at base on the outside, a little longer than the three following joints united; joint 2 as long as wide, less than half as long as 3; joints 3 to 12 subequal in length and width, a little over twice as long as wide; joint 13 as long as 2 and 3 united, sharply pointed apically; pronotum about as wide as long, polished, feebly emarginate anteriorly, the posterior angles rather prominent; mesonotum broadly transverse, traversed longitudinally by two parallel parapsidal grooves and by two carinæ, one to each side, bisecting the lateral lobes; these carinæ not complete, obsolete anteriorly; median lobe longer than wide, faintly shagreened; scutellum more or less triangular, polished, its ante-

rior angles elevated, sharp; axillæ not indicated; membranous plates on legs narrow, inconspicuous; abdomen about as long as the thorax, wider, longer than wide; last segment sharply recurved, acute apically; wings large and long, mostly glabrous; maculations as in *L. inermis;* veins similar also but the basal nervure represented only by a stump proximad; radius five times as long as the anterior abscissa of subcosta, beyond the short stump of the basal nervure, nearly vertical; radius oblique, straight. Reddish brown, flecked with large black spots; sutures of thoracic sclerites blackish.

BORNEO, Sandakan (*Baker*), 4 males.

Type.—Catalogue No. 24315, United States National Museum. Paratype returned to Baker.

Loboscelidia nigra sp. nov.

Female.—Length, 3.60 millimeters. Face finely, obliquely aciculate, with a delicate median carina, and with a lateral carina extending from the malar space to the occiput, nearly touching the eyes medially; ocelli very large, nearly touching one another, the lateral ones less than their diameter from the back of the head; antennal ledge as in *L. bakeri* but more developed below, triangular seen from in front; face below antennæ obliquely striate; antennæ much longer than the body, slender, becoming narrower beyond the third joint; scape thick, broad, carinate, seen from the side three times as long as wide, a little longer than the next two joints united; joint 2 transverse, one-fourth the length of the third, which is a little less than three times as long as wide; joint 13 equal to 12, broadly rounded apically, nearly five times as long as wide; dorsal neckplate highly arched, distinctly longer than wide, with a shallow longitudinal depression; cervical membranes long, golden colored, striated, overlapping the shorter ones projecting from the anterior margin of the pronotum; pronotum transverse, slightly arched anteriorly and posteriorly, not emarginate in front, with two wide, shallow depressions behind; posterior angles of pronotum sharp but not prominent; mesonotum broadly transverse, polished, the posterior angles sharp, projecting over the axillæ; parapsidal grooves complete, parallel; median lobes very little longer than wide; scutellum broad, polished, sloping posteriorly, obliquely striate at the posterior angles; axillæ separated off from the scutellum by pitted sutures; propodeum perpendicular, polished; membranes on the legs inconspicuous, those on the hind legs wider; metatarsus of hind legs bent basally, as long

as the last three joints united; each tarsal claw with a sharp inner tooth; abdomen 6-segmented, as long as the thorax, the last segment punctulate, slightly recurved; wings glabrous, without cilia; basal nervure complete, oblique, the median cell wide; transverse medius as long as the subcosta beyond the basal vein, straight, oblique, not touching the submedius which is only half as long as the subcosta; postmarginal vein one-seventh the length of the radius, the latter straight, oblique, as long as the basal; forewings with a transverse brownish band in the region of the radius; otherwise the wings are hyaline. Black, touched in places with rufous; tegulæ reddish, very large, convex, reaching to the apex of the scutellum, truncated apically.

MINDANAO, Dapitan (*Baker*), type. BASILAN (*Baker*), paratype.

Type.—Catalogue No. 24316, United States National Museum.

Loboscelidia antennata sp. nov.

Female.—Length, 2.50 millimeters. Head broadly transverse, much narrower than the thorax, as high as wide; cheeks very wide, wider than the compound eye, sparsely covered with long, erect, white hairs, as is also the rest of the head including the eyes; ocelli large, very close together, the lateral ones less than their diameter apart, more than their diameter distant from the posterior margin of the head; ocelli situated in a large immargined depression; frons, including the bases of the antennæ, inclosed by a perfect circle formed by a sharp carina, this carina passing close to the eyes and to the anterior ocellus; inclosed area finely reticulated, subconcave; antennal ledge not prominent, perpendicular in front, truncate below; antennæ 13-jointed, short and stout, not as long as the body, sparsely pubescent; scape seen from above like a knife edge, thickened distally, curved, viewed laterally three times as long as wide, oblong, with a narrow hyaline membrane below, as long as the five following joints united; joint 2 a little longer than wide, narrower than 1, slightly wider and shorter than 3; joints 4 and 5 subequal, as long as wide, as wide as 3, cylindrical; joint 6 shorter, transverse; joint 7 shorter than 6, more widely transverse; eighth joint as long as the seventh, wider; joints 9 to 12 about twice as wide as long, narrower than the scape; joint 13 as long as wide, broadly rounded apically, punctate; dorsal cervical plate triangular, narrowed anteriorly, strongly arched above, pubescent, not concave; on the side of this sclerite there is attached a striated membrane of the appearance of

matted hairs, the parts of which curve outward and forward, projecting over a similar but smaller structure on the posterior part of the head; on the pronotum below and behind these head structures is a membrane of much the appearance of the others, the structure of which can be more easily observed; it may be that the matted or woolly appearance referred to above is caused by inner striation of the membrane; pronotum broadly transverse, slightly narrowed anteriorly, not emarginate, its posterior angles sharp; pronotum finely reticulate, with two broad shallow depressions posteriorly; mesonotum a little over half as long as the scutellum, with a broad depression on the outside of each parapsidal groove; median lobe shagreened; scutellum large, transverse, longitudinally carinate, posteriorly shagreened, with a polished median groove; axillæ separated off by deep grooves; postscutellum medially roughened, mostly unsculptured; membranes on tibiæ and tarsi very wide, as wide as or wider than the joints to which they are attached; abdomen as wide as the thorax, shorter; ovipositor projecting, two-thirds as long as the scape; wings glabrous, very large and long, with a brownish band variegated with hyaline across the middle; transverse median nervure shorter than the subcosta beyond the basal, straight, perpendicular; radius three and one-half times as long as the anterior abscissa of the subcosta, nearly straight, oblique, as long as the basal; basal vein curved distad; median cell wide, half as wide as the radius is long; submedius less than half as long as the subcosta.

STRAITS SETTLEMENTS, Singapore (*Baker*), 1 female.

Type.—Catalogue No. 24317, United States National Museum.

This species is most remarkable and could possibly be placed in a new genus. In its antennal structure it differs from all the other species of *Loboscelidia*.

Loboscelidia philippinensis sp. nov.

Female.—Length, 4 millimeters. Head higher than long, the cheeks not wider than the eyes, without pubescence or with only a few scattered hairs; frons flattened, finely shagreened, bordered laterally by a rounded ridge which extends from the antennal ledge to the occiput; ocelli large, disposed in a low triangle, the lateral ones their diameter apart and their diameter distant from the back of the head; ocelli not situated in a depression, the anterior one-half its diameter or less from the others; antennal ledge bilobed; wider than high seen from in front; dorsal cervical plate regularly arched above, polished,

subconcave, longer than wide, its sides parallel; cervical membranes prominent, not so large as in *L. antennata,* not overlapping, those on the head and neck the longest, evenly corrugated; antennæ slender, as long as the body, the flagellum not narrowing toward tip, all the joints except the first cylindrical; scape with a wide membrane, seen from the side three times as long as wide, not quite as long as the next three joints united; joint 2 as wide as long, half as wide as the scape, one-third as long as 3; following joints to the twelfth subequal to the third, becoming a little shorter toward the tip of the antennæ; joint 13 two and three-fourths times as long as wide, broadly rounded apically, longer than 12; pronotum polished, as wide as long, sightly widened behind, truncated anteriorly, more or less concave in the middle, with an arcuate depression on posterior third; mesonotum polished, more than twice as wide as long, as long as the scutellum, less than half as long as the pronotum; parapsidal grooves deep, incomplete, not present on posterior one-fourth; scutellum a little wider than long, mostly polished and flattened, on the side posteriorly indistinctly striate; axillæ not separated off from the scutellum; postscutellum with a median ridge, either side of which is roughened; abdomen as long as the thorax, not recurved below at tip, polished; wings hyaline, with a brownish band across the middle, a large spot on costal margin at apical third, and dark streaks marking the submarginal and discoidal veins; basal nervure straight to distal third where it makes a sharp bend and enters the subcosta nearly at right angles; transverse median nervure a little shorter than the anterior abscissa of the subcosta, straight; median cell less than half as wide as the radius is long; radius oblique, as long as the basal vein, five times as long as the oblique anterior abscissa of the subcosta; membranes on femora and tibiæ wide but not so wide as in *L. antennata;* metatarsus of hind legs five and one-half times as long as wide, not sharply bent basally, as long as the next three joints united, wider than either; second joint twice as long as wide, wider and longer than the third; third twice as long as wide, wider and longer than the fourth; joint 4 more than half as wide as long, joint 5 three and one-half times as long as wide, narrower than 4, longer than 2; claws sharp, each with a short acute inner tooth. Rufous; femora and tibiæ touched with yellow.

MINDANAO, Ilagan (*Baker*), 2 females (type and paratype); Kolambugan (*Baker*), 2 female paratypes.

Type.—Catalogue No. 24318, United States National Museum. Paratype returned to Baker.

Loboscelidia maculipennis sp. nov.

Female.—Length, 3 millimeters. Head longer than high seen from the side, the cheeks not wider than the eyes; face flattened, deeply excavated in the region of the antennal sockets, carinate laterally, the ridge running from the antennal ledge to the occiput; face striate and aciculate, with a short longitudinal suture in the middle; ocelli not situated in a depression, close together, the lateral ones their diameters apart and their diameters distant from the posterior margin of the head; cheeks

FIG. 1. *Loboscelidia maculipennis* sp. nov.; head, lateral view.

and malar space polished, sparsely covered with curious, short, club-shaped hairs of a silvery color; antennal ledge long, prominent, not thick, rounded in front; dorsal cervical plate flattened, quadrate, the membrane not conspicuous, extending down upon the cheeks, not touching the pronotal membrane which is ear-shaped, prominent; antennæ longer than the body, the joints beyond the scape cylindrical, equally wide; scape three times as long as wide, narrowed slightly proximad, with a narrow membrane beneath; pedicel as wide as long, one-third as long as joint 3, which is subequal to 12; in one antenna joint 10 is subconcave below and in the other antenna joint 10 is concave above (probably an abnormal condition); joint 13 three

times as long as wide, rounded apically; pronotum wider than long, polished, concave above, truncated anteriorly; pronotum sloping abruptly anteriorly; mesonotum polished, shaped as in *L. philippinensis,* as wide as the scutellum; parapsidal grooves incomplete, not indicated behind; scutellum transverse, polished, flattened, striate behind on the sides; axillæ partly separated off by deep grooves; postscutellum polished medially, not ridged; abdomen as in *philippinensis;* wings maculated as in *philippinensis;* basal nervure slightly bent at distal two-fifths; membranes on femora and tibiæ narow, inconspicuous; front tarsi as in *philippinensis.* Body entirely rufous, the thoracic sutures blackish.

BORNEO, Sandakan (*Baker*), 1 female.

Type.—Catalogue No. 24319, United States National Museum.

This species may be the same as *L. philippinensis* but seems to be distinct. Intermediate forms are unknown, and it seems best to separate what seem to be the extremes.

Loboscelidia carinata sp. nov.

Female.—Length, 3 millimeters. Differs from *L. maculipennis* in a few minor particulars: face more strongly striate and granulose medially, with a sharp median carina; basal nervure bow-shaped, not so distinctly angulate; anterior wing hyaline, with a yellowish band across its middle.

STRAITS SETTLEMENTS, Singapore (*Baker*), 1 female.

Type.—Catalogue No. 24320, United States National Museum.

Loboscelidia defecta Kieffer.

In the lot received from Professor Baker is a series of fifteen specimens representing this species. Two were collected at Singapore, and the rest at Sandakan, Borneo. They agree very well with the original description.[2] Sometimes the anterior abscissa of the subcosta is present, but very short. Kieffer's figure shows the maculation of the wings very nicely. In some of the specimens at hand the spots are indistinct and merge together, or they are pale and hard to trace.

Loboscelidia brunnea sp. nov.

Female.—Length, 3 millimeters. Closely related to *L. defecta* Kieffer from which it differs as follows: Frons polished, shining, not shagreened, with the lateral ridges higher and sharper, and with a sharp median ridge on lower half; dorsal cervical plate

[2] Das Tierreich, Lief. 44 (1916) 18.

wider than long, distinctly concave above, smooth and shining; pronotum more strongly arched in front, depressed behind the cervical plate, across the middle a little wider than long; axillæ more sharply set off from the scutellum by deep grooves; radial nervure distinctly shorter than the basal, oblique; anterior abscissa of subcosta present, much shorter than the radius.

BORNEO, Sandakan (*Baker*), 1 female.

Type.—Catalogue No. 24321, United States National Museum.

Loboscelidia collaris sp. nov.

Female.—Length, 2.2 millimeters. Head as long as high, mostly without pubescence; frons flattened, scarcely excavated below, finely and evenly shagreened, carinate laterally, with the carina becoming obsolete above, not distinct on the vertex; cheeks and malar space finely shagreened; lateral ocelli their diameter distant from each other and from the back of the head; antennal ledge short, bilobed as seen from above, with a lower projection, the whole structure of a triangular shape when observed from in front; above the clypeus is an acute median carina; antennæ longer than the body, slender, the joints beyond the first subequal in width; scape compressed, slightly narrowed basally, seen laterally three times as long as wide, as long as the next three joints united; joint 2 as wide as long, nearly half as long as 3; joints 3 to 12 subequal in length and width; joint 13 longer, almost as long as 2 and 3 united, subacute apically; dorsal cervical plate longer than wide, slightly narrowed anteriorly, strongly arched above; space between the head and thorax filled by the golden lobes of the woolly substance noted in my description of *L. antennata;* the membranes overlap one another and the result is a billowy appearance; pronotum wider than long, truncate anteriorly, flattened posteriorly, more or less arched in front, with two broad, shallow depressions behind the middle; mesonotum three times as wide as long, shorter than the scutellum, the median lobe shagreened, the lateral ones sharply carinate on the outside, each with a submarginal depression; parapsidal grooves complete; scutellum flattened, longitudinally striate; axillæ separated off by deep furrows; postscutellum with a low ridge medially, polished; abdomen as in *L. defecta;* wings hyaline, with a brownish band across the middle of each, and with a pale brown spot behind the band along the costal margin; basal nervure slightly curved distally, as long as the radius, four times as long as the anterior abscissa of the subcosta; nervulus shorter than the

subcosta beyond the basal, a trifle shorter than the anterior abscissa; submedian very short, much less than half as long as the subcosta; hyaline plates on femora and tibiæ very wide, on hind legs wider than the joints to which they are attached; metatarsus of hind legs four times as long as wide, slightly bent near the base, distinctly shorter than the three following joints united; joint 5 as long as 3 and 4 united, nearly four times as long as wide. Rufous; margin of the pronotum and the tegulæ in part blackish.

STRAITS SETTLEMENTS, Singapore (*Baker*), 1 female.

Type.—Catalogue No. 24322, United States National Museum.

Loboscelidia scutellata sp. nov.

Female.—Length, 3 millimeters. Differs from *L. collaris* as follows: Head higher than long, covered with long silvery hairs below; cheeks polished, as wide as the eyes; face strongly shagreened, with a median carina below; carinæ on the sides of the face sharp, extending to the occiput; ocelli very close together, the lateral ones less than their diameter from each other and from the posterior margin of the head; scape less than three times as long as wide, a little shorter than joints 3 and 4 united; joint 2 as wide as long; joint 3 as wide as 2 and any of the joints following it, two and one-half times as long as the second joint; following joints becoming gradually longer and narrower, the middle ones slightly curved; joint 13 as long as 2 and 3 united, five times as long as wide, subacute at tip; dorsal cervical plate scarcely narrowed anteriorly, longer than wide, with a shallow median depression; pronotum a little wider across the middle than long, somewhat wider posteriorly, polished; mesonotum shining, two and one-half times as wide as long, as long as the scutellum; parapsidal grooves complete, the median lobe subconcave; scutellum finely longitudinally striate; axillæ separated off by deep grooves; postscutellum slightly elevated medially, polished; wings subhyaline, darker around the radius; nervulus longer than the anterior abscissa of the subcosta, straight; basal nervure nearly straight, slightly curved distad, as long as the radius; anterior abscissa of subcosta longer, about half as long as the subcosta before the latter forks, straight; plates on femora and tibiæ narrow, not wider than the joints to which they are attached; metatarsus a little over four times as long as wide, nearly as long as the next three joints united. Coloration as in *L. collaris* sp. nov.

BASILAN (*Baker*), type. MINDANAO, Surigao (*Baker*), 1 paratype. Five specimens received.

Type.—Catalogue No. 24323, United States National Museum. Paratype returned to Baker.

BETHYLIDÆ

Lestodryinus stantoni Ashmead.

Dryinus stantoni ASHMEAD, Proc. U. S. Nat. Mus. 28 (1904) 134 (♀).
Prodryinus stantoni (Ashmead) KIEFFER, André, Spec. Hym. Eur. 9: 498; Das Tierreich, Lief. 41 (1914) 53.

Runs in Kieffer's key [3] to *L. perkinsi* Kieffer and differs from that species as follows: Frons with many variously curved longitudinal carinæ, and with a high and sharp median ridge below the anterior ocellus, clothed with short silvery hairs; clypeus wider than long, wide anteriorly, the two teeth rounded and far apart; mandibles blackish medially, brown basally, and with rufous teeth; first and second antennal joints yellowish brown; 3 to 9 black; joint 9 one and one-half times as long as wide; joint 10 yellow, longer than 9, slightly narrowed distally; mesonotum two-thirds as long as the pronotum, measuring the latter from its anterior border to the apices of the lateral lobes, finely granular, somewhat more coarsely so posteriorly, densely covered with short silvery hairs; postscutellum granular, half as long as the scutellum; upper face of propodeum bordered posteriorly by a low ridge and with another ridge immediately in front of the other; distal part of radius hardly longer than the proximal part; postmarginal short, not well pigmented, much shorter than the parastigma; legs rufous, variegated considerably with blackish; middle and posterior tibiæ, metatarsus, and last tarsal joint piceous; other tarsal joints reddish; front femora gradually narrowed distally, thick basally, brown; front coxæ hardly over half as long as the femora, brown with yellow markings; lateral claw of chela with a row of nine widely separated white spines, the distal tooth minute, hard to see; last segment of abdomen thickly covered with short white hairs on apical half; abdomen mostly black, the last segment yellowish brown.

Length, 4.5 millimeters.

LUZON, Manila.

[3] Das Tierreich, Lief. 41 (1914) 20.

Type.—Catalogue No. 8000, United States National Museum. Redescribed from the type specimen in the United States National Museum.

Lestodryinus kiefferi sp. nov.

Female.—Length, 6.5 millimeters. Head a little over two-thirds as long as wide, flat above, its posterior margin acute, straight; head strongly excavated below the upper posterior margin, attached to the thorax at its ventral surface, wrinkled and with a rather deep longitudinal furrow below; frons shagreened, with many wavy longitudinal wrinkles, and with a median carina; hind margin of eyes projecting beyond the head posteriorly; median carina not reaching the clypeus; clypeus granular, wider than long, bidentate at apex, the emargination arcuate; malar space two-thirds the length of the clypeus, longitudinally striate; mandibles 4-dentate, the lower tooth the longest; maxillary palpi 5-jointed, brown; fifth joint hardly longer than the fourth, yellow, blunt apically; labial palpi 3-jointed, brown; first joint three times as long as wide, devoid of pubescence, as long as the second; second joint scarcely longer than wide, flattened, densely covered with long white hairs; third joint much longer, threadlike, nearly as long as the first two united, finely pubescent; scape more than twice as long as the pedicel; scape and pedicel united not quite three-fifths the length of joint 3; joint 3 scarcely widened apically, less than twice as long as 4; joints 8 to 10 yellow; 10 longer than 9, as long as 7, blunt apically; pronotum mostly granular, finely pubescent, somewhat elevated posteriorly, without a transverse incision anteriorly; mesonotum rugose, inconspicuously pubescent, the parapsidal grooves complete but shallow and nearly lost in the rough sculpture; scutellum rugose, with a deep narrow depression across its base, the depression divided medially by a narrow partition; propodeum irregularly reticulate, a condition similar to that found in *Psilodryinus reticulatus* sp. nov.; propodeum rounded apically, somewhat excavated behind, the excavation bordered on each side by a longitudinal ridge; abdomen as long as the thorax, somewhat flattened; the last two segments compressed, the seventh more strongly so than the sixth; segments 1 to 5 finely granular, opaque, sparsely pubescent; 6 shining, with a few large scattering punctures; segment 7 triangular seen from the side, rounded apically, like a knife edge seen from above, finely and closely pubescent and punctate; seventh tergite very small, triangular, with a row of

long black hairs on each side posteriorly; ovipositor projecting the length of the sixth tergite, yellow, the sheaths brown; wings hyaline, with two brown transverse bands, the inner one narrow and inconspicuous, the outer one broad and well defined; radius not half complete, well pigmented, not much longer than the basal; nervulus interstitial with the basal, narrowly interrupted before it reaches the medius; legs long; front coxa as long as the metatarsus, not so thick as the femur; trochanter narrower than the coxa, two-thirds as long; femur as long as the coxa and trochanter united; a trifle longer than the tibia; metatarsus longer than all the following joints united; joint 4 flattened, longer than 2 and 3 united; inner claw of chela about as long as joints 2 to 4 united, furnished inside with a double row of short throns; outer claw slightly curved, with a row of thorns inside claws on middle and hind legs with an inner tooth basally. Black; mandibles, antennal socket, last three antennal joints, chela, metatarsus of anterior legs apically, and the other tarsal joints entirely, last segment of abdomen, rufous for the most part.

LUZON, Mount Maquiling (*Baker*).

Type.—Catalogue No. 24324, United States National Museum.

This species, known from a single specimen, differs from *L. luzonicus* Kieffer in the color of the antennæ and in having the radius shorter. Other differences occur and may be recognized by comparing my description with Kieffer's.[4]

Psilodryinus thoracicus sp. nov.

Female.—Length, 5 millimeters. Very closely related to *P. sumatranus* of Enderlein, from which it differs as follows:

Distance of lateral ocelli from each other more than half their distance from the anterior one; posterior margin of pronotum not emarginate, the lateral lobes not in evidence; elevation on posterior lobe of pronotum with many transverse carinæ anteriorly; wings colored with a light brown; first abscissa of cubitus, discoideus, first recurrent, and subdiscoideus visible as white lines in the semiopaque transverse wing band; basal vein well pigmented to distal third; cubitus and subdiscoideus visible as brownish lines distad of the whitish transverse band, not reaching the wing margin; legs dull reddish except as follows: Anterior trochanters, tibiæ basally, most of femora, posterior metatarsus except at apex, middle and hind tibiæ,

[4] Das Tierreich, Lief. 41 (1914) 24.

metatarsi, and last joint of tarsi dark brown or fuscous; fourth joint of posterior tarsi considerably longer than 2 and 3 united, two-thirds as long as the first; lateral claw yellow, unarmed except for a short tooth subapically; head and thorax closely covered with short silvery hairs.

PALAWAN, Puerto Princesa (*Baker*), 1 female.

Type.—Catalogue No. 24325, United States National Museum.

Psilodryinus reticulatus sp. nov.

Female.—Length, 6.5 millimeters. General structure as in *P. thoracicus* sp. nov.; face with many parallel longitudinal ridges which extend back on the occiput, with a median carina; interocellar space traversed by several of the facial carinæ; clypeus rounded apically, shagreened; labial palpi 3-jointed, short; joint 1 twice as long as wide, as wide as 2 but a little longer, not quite as long as 3; 3 blunt at apex, much narrower than 1 or 2, threadlike; maxillary palpi 5-jointed; first joint twice as long as wide, half as long as 2, as wide as 2 distally; joint 2 widened apically, a little shorter than 3 but much wider; joint 3 as wide as 4 or 5, as long as 5, a little longer than 4; joint 5 pointed apically, threadlike; scape twice as long as the pedicel; pedicel over twice as long as wide, wider than joint 3; joint 3 very long, over two and one-half times as long as the scape, very slender, widening distally; joint 4 nearly two-thirds as long as 3, a little longer than 5; joint 6 half as long as 4, four times as long as wide, following joints except the tenth becoming gradually shorter; joint 10 as long as 7, blunt apically; pronotum closely punctulate, very little longer than wide, somewhat narrower than the thorax, highly elevated behind the horseshoe-shaped incision, the elevation anteriorly with a few sharp transverse carinæ; mesonotum with two diverging carinæ in the position usually occupied by the parapsidal grooves, with a median carina; inclosed areas finely punctate, covered with short white hairs; scutellum with four foveæ basally, the lateral ones the largest, with longitudinal and transverse carinæ intersecting; propodeum evenly convex, covered with small polygonal areas bordered by curved raised lines, without pubescence; legs black except the lateral claw of the chela; front coxæ long, reaching a little behind the posterior margin of the prosternum, densely pubescent beneath; front trochanters long, curved medially, thickened distally, half as long as the femora; femora a little longer than the tibia, thicker, narrowed distally; tibiæ gradually narrowed proximally; posterior metatarsus not

quite half as long as the tibia, equaling in length the distance from the base of the fourth joint to the apex of the fifth; fourth joint much longer than the second and third united, widened distad; median claw of chela as long as joints 1 to 4 united, with a row of short white plates below; lateral claw yellow, bare, curved behind the middle, narrow, as long as joints 1 and 2 united, with a short tooth before the apex; legs entirely covered with a short white pubescence; tarsal claws sharp, without teeth; wings as in *P. thoracicus,* but with a narrow transverse band in the region of the radius and with the radius a little shorter; it can be clearly seen that the darker color of the wings is due to the presence of pigment in the hairs; abdomen rather long, sharply pointed and narrowed toward apex, polished, sparsely covered with short white hairs; first segment bell-shaped, of the form found in the wasps of the subgenus *Odynerus;* sixth segment shorter than the fifth, longer below than above; ovipositor projecting the length of the last tergite. Body black; antennæ at tip and abdomen at base and apex touched with rufous.

LUZON, Los Baños (*Baker*), 2 females.

Type.—Catalogue No. 24326, United States National Museum.

One specimen has the ovipositor more in evidence. The abdominal segments are telescopic and so the relative proportions vary considerably.

Genus **NEOANTEON** novum

Head transverse, wider than the thorax, margined and slightly arcuate posteriorly; face convex; cheeks rather wide, narrower than the eyes; eyes large, bare, converging slightly anteriorly; ocelli present, arranged in a small triangle; clypeus transverse; mandibles 4-dentate, the second and fourth teeth the largest; upper tooth a little longer than the third; maxillary palpi 5-jointed; antennæ 10-jointed, joints 3 to 9 of somewhat similar shape and size; thorax short, wider than high, scarcely longer than wide; mesonotum transverse, longer than the pronotum, with the parapsidal grooves briefly indicated anteriorly, far apart; pronotum inconspicuous seen from above, somewhat constricted medially; scutellum transverse, unarmed, with a narrow and deep fovea across its base; propodeum areolated, with ten inclosed spaces, declivous, with a broad vertical impression laterally; abdomen small, with a long petiole, constricted below between the petiole and the second sternite; wings normally developed, maculate; venation generally as in *Anteon*

Jurine; radius with proximal abscissa straight, a trifle longer than the distal abscissa which is slightly curved, almost reaching the wing margin; submedian cell nearly as long as the median, the nervulus oblique; brachius short, well pigmented basally; basal vein shorter than the first abscissa of the radius, abruptly angulate before it attains the subcosta; prostigma absent, parastigma half-elliptical, shorter than the basal nervure; hind wings without a cell; legs moderately long; metatarsus of hind legs longer than the fourth joint which is longer than 2 and 3 united; claws of chela strongly curved, short, the inner one with a broad blunt tooth medially, and the outer one with a rather long sharp tooth below at distal third; otherwise the claws are unarmed; claws of middle and hind legs sharp, without dentition.

This genus comes closest to *Anteon*. It differs principally in its pedicellated abdomen and in the peculiar structure of the chelæ which are devoid of bristles and lamellæ. The venation also offers minor differences.

The genotype is from the Philippine Islands and may be known under the name:

Neoanteon rubrica sp. nov.

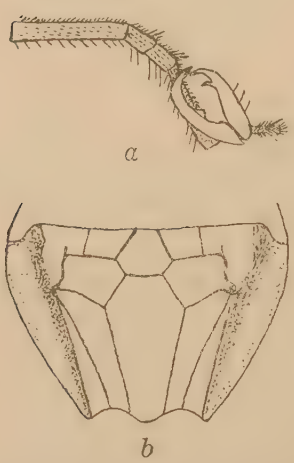

FIG. 2. *Neoanteon rubrica* sp. nov.; *a*, anterior tarsus, lateral view; *b*, propodeum, dorsal view.

Female.—Length, 3 millimeters. Entire body shining, without strong sculpture, finely and sparsely pubescent; face with scattered punctures, with a median carina extending from the anterior ocellus to the clypeus; subconvex, rounded anteriorly; scape short, nearly as long as joints 3 and 4 united; joint 2 a little shorter than 3; joints 3 to 6 subequal, a little longer but no wider than joints 7 to 9; joint 10 longer, broadly rounded apically; mesonotum with a few scattered punctures; propodeum areolated as shown in fig. 2; abdomen as long as the head and thorax united, depressed, mostly without pubescence; petiole slender, seven times as long as wide, as long as the propodeum; second tergite scalelike, longer than the petiole, broadly rounded apically, its sides extending around the base of the petiole in a wide subhyaline plate; third segment as long as all the follow-

ing united, shorter than the second; segment 4 longer than 5; segment 6 compressed, a little longer than the fourth; anterior coxa as long as the pronotum, densely pubescent below; femur longer than the coxa and trochanter united, wider than the coxa; tibia as long as the first three tarsal joints united, its distal spur blunt, finely pubescent; metatarsus twice as long as the next two joints united, about six times as long as wide; joints 2 and 3 equal, as long as wide; empodium half as long as the fourth joint; wings smoky, with three transverse brown bands, one through the basal, one through the radius, and the other near the apex. Rufous; scape, pedicel, base of third joint, joints 7, 8, and 9, clypeus, mandibles except the teeth, and all the legs straw-colored; antennal joints, other than those mentioned above, dark brown.

LUZON, Los Baños (*Baker*), 2 females.

Type.—Catalogue No. 24327, United States National Museum.

BRACONIDÆ

Helorimorpha fumipennis sp. nov.

Female.—Length, 4.5 millimeters. Head as wide as the thorax, twice as wide as long, strongly punctate, a white hair issuing from each puncture; middle of face somewhat less strongly punctate; clypeus broadly transverse, slightly and broadly emarginate apically, flattened, finely punctate; mandibles long, the upper tooth longer than the lower, very sharply pointed; antennæ originating above the middle of the face, as long as the body, all the joints subequal in width, cylindrical; scape punctate, more than twice as long as wide; joint 2 a little longer than wide; 3 narrowed basally, as long as the scape; following joints to the seventeenth becoming gradually shorter; joint 18 as long as 7, sharply pointed apically, two and one-half times as long as wide; face with a sharp keel between the antennæ; aperture inclosing antennal socket opening upward, circular; thorax short, two-thirds as wide as long, as high as wide, marked all over with large, shallow, five- or six-sided pits bordered with low rounded ridges; parapsidal grooves not indicated; propodeum quadrate, broadly and shallowly excavated on its posterior face; first abdominal segment six-sevenths as long as the thorax, slender, curved, gradually widened apically, much narrower than the hind coxæ; abdomen entirely polished, the segments beyond the first forming a solid piece, as long as the thorax; wings brownish, hyaline apically, basally (including the entire basal cell), and medially in a narrow band dividing

the first cubital cell and the second discoidal at base; veins brown; first transverse cubitus straight, as long as the second abscissa of the cubitus; first abscissa of the radius straight, as long as the second abscissa and second transverse cubitus united, the latter a little longer than the former; discoidal vein short beyond the second transverse cubitus, represented by a long brown streak distally; third abscissa of radius straight, reaching the postmarginal which extends slightly beyond their junction. Body shining black; legs yellowish brown to piceous, the coxæ and most of hind legs darker; antennæ yellowish brown basally, piceous toward the apex.

Male.—Length, 4.5 millimeters. Differs little from the female. Only by the slightly extruded genitalia can I determine one specimen as the male. The ovipositor may be seen in the type by the use of the highest power of the binocular microscope. It is nearly concealed beneath the overhanging edges of the apical sternites.

MINDANAO, Dapitan (*Baker*), 2 specimens.

Type.—Catalogue No. 24328, United States National Museum.

This species differs from *H. fisheri* and *H. brasiliensis* in having the body black, and from *H. egregia*, the genotype, in having the wings tinged with brown.

ILLUSTRATIONS

TEXT FIGURES

EFFECT OF DIFFERENT RATES OF TRANSPIRATION ON THE DRY WEIGHT AND ASH CONTENT OF THE TOBACCO PLANT [1]

By Nemesio B. Mendiola

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REVIEW OF PREVIOUS WORK

Authorities are divided in their views regarding the relationship between the rate of transpiration of a plant and the intake of soil solutes. On the one hand it is held that the amount of solute taken up by the plant from the soil solution is proportional to the amount of water transpired, while on the other the amount of solute taken in by the plant is believed to be independent of the amount of water transpired. The available experimental data relating to this question are few.

As early as 1849 Lawes,(1) while realizing the relationship of evaporation to rapidity of growth to be yet a problem, nevertheless assumed generally that the comparative rate of evaporation of water to some extent indicates the comparative activity of the processes of the plants. In his experiments with wheat, barley, beans, peas, and clover, in which he determined the amount of water given off by the plants and the amount of dry matter and ash obtained from them, he got a greater amount of dry matter and ash with a greater amount of water, and vice versa. It should be remarked, however, that the plants were not given the same soil treatments. He merely concluded that these experiments indicated some definite relationship between the passage of water through the plants and the fixation in them of some of their constituents.

Schloesing,(2) in 1869, grew one tobacco plant under a shaded bell jar and three in the open. The water evaporated per plant in the open averaged more than three times that evaporated

[1] A report on the research problem presented in 1917 to the department of botany, Cornell University, to satisfy in part the requirements for a minor in plant physiology.

under the bell jar. He found a greater percentage of total ash in the leaves of the plants grown in the open than in those of the one plant under the shaded jar. This experiment is of little or no value, as only the leaves were analyzed and only very few plants were grown. It is interesting to note, however, that he assumed the difference in the ash content to be due to the difference in total transpiration.

According to Hasselbring(10) Fittbogen expressed in 1871 an idea similar to that of Lawes.

Sorauer,(3, 4) in 1878–1880, grew various species of plants such as barley, pea, lupine, and others in humid and dry conditions and found in general a greater amount of dry substance and a higher percentage of ash under dry conditions than under humid.

Hasselbring(10) again tells us that in 1883 Hellriegel considered there was no relationship between transpiration and the production of dry matter, and that Kohl in 1886, on anatomical grounds, assumed that a rapidly transpiring plant receives, by means of the transpiration stream, far greater amounts of mineral nutrients than a plant with lower transpiration.

Wollny,(5) in 1898, grew barley, vetch, lucerne, and flax under dry, moist, and medium conditions. In general he found greater absolute amounts of fresh and dry substances and a higher percentage of ash under humid conditions than under dry atmosphere. Pfeffer(6) remarks that these results of Wollny were probably due to the necessary protection against transpiration in dry air retarding the gaseous exchange, and thus also carbon dioxide assimilation and growth. After citing the results of the experiment of Schloesing already referred to in this review, Pfeffer expressed the belief that transpiration favors the absorption of the constituents of the ash.

In 1905 Livingston,(7) experimenting with wheat seedlings, published the conclusion that total transpiration of wheat plants grown in various media is as good a criterion for comparing the relative growth in these media as is the weight of the plants.

Jost,(8) in 1907, without presenting any data, states in his text that plants which transpire freely are far richer in ash than those transpiring feebly. He appears to be convinced that transpiration greatly helps in the absorption from the soil of large quantities of salts.

Thatcher,(9) 1913, performed some analyses of wheat grains to determine the effect of sunlight on their composition. The plants were grown under canvas cover and in the open. In seven of nine cases he found very significantly higher percentage of

ash in the shaded plants than in those of the open. In the remaining cases the difference was in favor of the unshaded plants, but the difference was very slight. It is hardly necessary to point out that these results are not of much value to the present study, as only a part of the plant, the grain, was considered. Thatcher gives us also an account of an experiment carried out by Murinoff, at the University of Halle, in which "etiolated" plants were compared with normal green plants. It was found that the percentage of ash was slightly higher in the normal green plants.

Hasselbring,(10) in 1914, grew tobacco plants under cheesecloth and in the open. Using entire plants in the analysis, he found that the absolute amounts of dry substance were about equal in the two sets, even if the plants in the open absorbed about 28 per cent more water than did the shaded ones. He found smaller amounts of ash in the unshaded plants, but the difference is within the limits of individual variation in the same set. In another experiment the transpiration per unit area of leaf surface was nearly twice as great in the sun plants as in the shaded plants, but the total quantity of dry substance produced was the same in both sets of plants. He considers these results as a suggestion that transpiration in itself, or the mere passage of water through the plant, has no influence on the assimilatory activity, provided the water supply does not fall below a certain minimum required to maintain the turgor of the cells. In conclusion he states that the absorption of salts by roots is independent of the absorption of water and that the transpiration stream does not exert an accelerating effect on the entrance of salts.

Kiesselbach,(11) in his study of transpiration as a factor in crop production, determined the effect of various factors upon the relation of transpiration to ash content. He grew corn plants in dry and humid greenhouses. Ash determinations were made of the entire plant. It was found that there was no absolute correlation between the percentage of ash and the quantity of water transpired per gram of ash content or the transpiration per gram of dry matter.

Harris and his coworkers,(12) in a recent paper on the relationship between the osmotic concentration of leaf sap and height of leaf insertion in trees, report that the relative concentration of electrolytes decreases from lower to higher levels, and this they take to indicate that the differences are due to increased photosynthesis in the upper regions of the tree rather than to the

concentration of salts from the soil solutes by increased transpiration.

In order to obtain some sort of collective idea as to the nature of the available experimental data on the subject, the results of the different experiments are grouped in Table 1. Where more than one experiment was reported with each kind of plant, only the average is shown.

TABLE 1.—*Data on the effect of different degrees of humidity and sunlight on dry weight and ash content of plants.*

Investigator.	Plant.	Ash.		Dry substance.		Fresh substance.	
		Dry or open.	Humid or shaded.	Dry or open.	Humid or shaded.	Dry or open.	Humid or shaded.
		g.	*g.*	*g.*	*g.*	*g.*	*g.*
Hasselbring	Tobacco, entire plant.	18.25	21.08				
Do	do			188.42	188.14	993	1,163
Schloesing	Tobacco leaves	21.8	13.0	37.4	48		
		P. ct.	*P. ct.*				
Kiesselbach	Corn, entire plant	7.01	7.12	218.0	287.1		
Thatcher	Wheat grains	2.38	2.72				
Sorauer	Barley, entire plant.			0.287	0.185	3.8	3.09
Do	Pea, entire plant	11.7	10.5	0.107	0.107	1.05	1.24
Tschaplowitz (5)	*Tropaeolum majus*			1.0	1.2	8.7	10.7
Wollny	Vetch	11.67	12.46	0.4	0.5	2.0	2.82
Do	Lucerne	10.87	10.56	0.15	0.22	0.82	1.24
Do	Flax	7.89	8.11	0.11	0.13	0.44	0.63
Do	Barley	10.78	10.34	0.33	0.51	1.26	2.16

As far as the figures in Table 1 are concerned, it can easily be seen that differences in humidity and sunlight have no effect on the dry weight and ash content of the plant, and, if anything, the effect has been to make plants grown under humid or shaded conditions richer in dry matter and ash than those grown in dry or open atmosphere.

EXPERIMENTS

Material used.—The plant used in this experiment is the tobacco plant, *Nicotiana tabacum*. The seeds were obtained from the plant breeding department of the New York State College of Agriculture through the kindness of Mr. Casey Fraser, according to whom the seeds came from an inbred plant.

Germination.—The seeds used in Crop I were germinated between layers of moist filter paper in an incubation box. This method did not prove to be as convenient as was desired since it necessitated the early removal of the seedlings from the ger-

mination plates when they were still too small to be transferred into the culture medium. In Crop II, therefore, seeds were germinated in sand in a seed box.

Culture.—All plants were grown in water cultures; those of the first crop in Erlenmeyer flasks of 2,000 cubic centimenters' capacity. The nutrient solution was prepared according to the following modified Pfeffer's formula:

	Gram per liter.
Calcium nitrate	0.4
Sodium chloride	0.1
Magnesium sulphate	0.1
Monopotassium phosphate	0.1
Ferric phosphate	0.1
Potassium nitrate	0.1

To obtain different environmental conditions that should permit of different amounts of transpiration, the plants were grown in two glass chambers, each of about 432 cubic decimeters' capacity. One was "humid," the other, "dry." In the humid chamber a pan of water whose surface area was nearly equal to that of the bottom of the room was kept throughout the experiment. No pan was used in the dry chamber; instead, there was a small electric fan which was allowed to run for a portion of the time of experimentation. As the two rooms were kept closed all the time except while changing the solution or watering, provision was made for some change of air inside. A tube about 7 millimeters in diameter led from each chamber to the outside, where they met in a T-tube which was connected with a Richard's suction pump.

Some idea of the difference in relative humidity and temperature in the two culture chambers can be obtained from the temperature and Lembrecht polymeter readings which were taken at intervals on July 26 and 27 and are recorded in Tables 2 and 3.

TABLE 2.—*Temperature and humidity readings on July 26, 1917.*

No.	Time.		Humid room.		Dry room.		Weather.
			Relative humidity.	Temperature.	Relative humidity.	Temperature.	
	a. m.	*p. m.*	*Per cent.*	*°C.*	*Per cent.*	*°C.*	
1	8.00		68	29.0	55	31.0	Bright, sunny.
2		12.30	53	32.7	45	35.1	Do.
3		3.00	51	34.0	41	36.4	Do.
4		4.00	62	32.3	62	33.4	Cloudy.
5		6.00	76	28.0	70	28.1	Rainy.

TABLE 3.—*Temperature and humidity readings on July 27, 1917.*

No.	Time.		Humid room.		Dry room.		Weather.
			Relative humidity.	Temperature.	Relative humidity.	Temperature.	
	a. m.	*p. m.*	*Per cent.*	°*C.*	*Per cent.*	°*C.*	
1	8.30		82	23.1	78	23.7	Cloudy.
2	9.30		78	26.9	64	28.0	Sunny.
3	10.30		56	30.0	42	33.0	Bright, sunny.
4	11.30		50	31.0	40.5	34.4	Do.
5		12.30	49	31.9	40	35.0	Do.
6		1.30	51	31.5	44	34.0	Do.
7		2.30	54	32.0	46	34.2	Do.
8		3.30	54	32.0	48	33.5	Do.
9		4.30	61	30.5	56	31.1	Cloudy.
10		5.30	71	31.0	66	31.4	Sunny.

Analyses.—Dry weight determinations were made by drying the samples or the whole material to constant weight in an electric oven at temperatures between 105 and 110° C. To get the ash, the dried material was burned in porcelain crucibles in an electric furnace, also to constant weight. Except when otherwise stated, each plant was analyzed separately, and analyzed for ash content in root, stem, and leaves.

RESULTS OF EXPERIMENTS

CROP I

Seeds germinated, May 13, 1917.
Seedlings transferred to culture solutions, May 17, 1917.
Plants placed in dry and humid chambers, June 13, 1917.
Solutions changed, June 29, July 16, July 29, and August 13, 1917.

HARVEST I, JULY 25, 1917

The heights of all the plants on the day of the first harvest are given in Table 4.

TABLE 4.—*Heights of plants on the day of the first harvest.*

Plant No.	Humid.	Dry.
	cm.	*cm.*
1	21.5	20.5
2	19.7	19.5
3	20.0	18.9
4	17.7	16.8
5	16.2	12.0
6	11.5	17.4
7	4.3	14.0
8	10.0	11.5
9	4.5	12.0
Average	13.9	15.8

In this harvest only three plants were taken as samples from each chamber; namely, plants 5, 6, and 8 from the humid room and plants 4, 8, and 9 from the dry room.

The average height of the harvested plants, number of leaves per plant, average length of roots, and average weight of roots, stems, and leaves per plant were determined, and the figures in Table 5 were obtained.

TABLE 5.—*Data from harvested plants.*

Average—	Humid.	Dry.
Height of plants ..... cm..	12.6	13.4
Number of leaves	12.6	12.6
Length of leaves ..... cm..	21.1	33.0
Weight of fresh roots ..... g..	0.156	0.495
Weight of fresh stems ..... g..	1.403	1.563
Weight of fresh leaves ..... g..	4.516	5.426

Tables 6 and 7 contain the figures obtained from moisture and ash determinations, respectively; the percentages of moisture are based on fresh weights, while those of ash were figured on the dry-weight basis.

TABLE 6.—*Moisture content.*

	Humid.	Dry.
	Per cent.	*Per cent.*
Roots	66.5	79.6
Stems	92.8	92.9
Leaves	86.7	92.1

TABLE 7.—*Ash content (average of three plants).*

	Humid.	Dry.
	Per cent.	*Per cent.*
Roots	8.19	6.64
Stems	8.02	7.72
Leaves	10.44	11.05

HARVEST II, AUGUST 19, 1917

Tables 8, 9, 10, and 11 contain the data obtained from analyses of the second harvest. The lengths of tops and roots and the total number of leaves at the harvest time are given in Table 8. Table 9 contains the dry weights; Table 10, the percentages of ash; and Table 11, the absolute dry weights and percentages of total ash.

TABLE 8.—*Lengths of tops and roots and total number of leaves.*

Plant No.	Humid.			Dry.		
	Length of top.	Length of roots.	Leaves.	Length of top.	Length of roots.	Leaves.
	cm.	*cm.*		*cm.*	*cm.*	
1	57.6	27.5	19	34.5	27.0	16
2	51.2	26.5	19	33.0	24.5	16
3	43.7	28.0	17	46.5	29.0	17
4	23.5	23.0	16	37.8	23.5	16
5	51.0	22.0	18	44.6	23.5	19
6	25.5	24.5	14	50.5	24.5	17
Average	42.1	25.2	17.2	41.1	25.3	16.8

TABLE 9.—*Absolute dry weights.*

Plant No.	Humid.			Dry.		
	Roots.	Stem.	Leaves.	Roots.	Stem.	Leaves.
	g.	*g.*	*g.*	*g.*	*g.*	*g.*
1	0.5140	1.3895	1.4144	0.3629	0.7836	1.2568
2	0.5560	1.1641	1.6279	0.4153	0.7756	1.3993
3	0.3624	0.9910	1.3770	0.5610	1.1734	1.7679
4	0.2209	0.3829	0.8667	0.3288	0.9837	1.2375
5	0.4241	1.1150	1.5710	0.5307	1.0878	1.5372
6	0.2055	1.4174	0.8283	0.5934	1.2200	1.6020
Average	0.3805	1.0766	1.2809	0.4653	1.0040	1.4668

TABLE 10.—*Percentage of ash in individual plants.*

Plant No.	Humid.			Dry.		
	In roots.	In stem.	In leaves.	In roots.	In stem.	In leaves.
	P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
1	6.13	3.20	5.50	6.83	3.62	5.94
2	7.24	3.60	6.07	6.54	3.88	6.53
3	8.14	3.47	4.77	7.62	3.39	5.38
4	8.42	5.17	8.33	7.02	3.31	6.14
5	7.34	3.60	5.52	7.68	3.60	6.19
6	6.91	5.22	8.18	7.11	3.55	6.47
Average	7.36	4.04	6.39	7.13	3.56	6.11
Probable error of mean[a]	±0.21	±0.23	±0.38	±0.11	±0.05	±0.11

[a] Probable error of the average was calculated according to the formula:

$$\text{P. E.} = \sqrt{\frac{\Sigma fd^2}{n}} \times \sqrt{\frac{0.6745}{n}}$$

P. E., probable error of the mean; Σfd^2, summation of the squares of the deviations of the values from the mean; n, number of individuals; 0.6745, a constant.

TABLE 11.—*Total dry weights and percentages of total ash.*

Plant No.	Humid.		Dry.	
	Dry matter.	Ash.	Dry matter.	Ash.
	g.	*P. ct.*	*g.*	*P. ct.*
1	3.3179	4.64	2.4033	5.31
2	3.3480	5.41	2.5902	5.74
3	2.7304	4.75	3.5023	5.07
4	1.4705	7.52	2.5500	5.16
5	3.1101	5.08	3.1557	5.55
6	2.4512	6.36	3.4154	5.54
Average	2.7380	5.63	2.9361	5.39
Probable error of mean	±0.1790	±0.28	±0.1206	±0.06

CROP II

Crop II consisted of two series; one series was kept in the same chambers in which Crop I was grown and is a repetition of Harvest I of that crop. This repetition was thought to be necessary as in Harvest I of Crop I no ash determinations were made of individual plants, and so the individual variation as well as the probable error of the average could not be determined. The second series of Crop II was grown in glass chambers also in which temperature and relative humidity were not supposed to be the factors controlling the relative rates of transpiration but rather the different intensity of illumination. One of the chambers was covered with white canvas cloth, and the other was left uncovered. The doors of both rooms were left open a little throughout the experiment to allow some circulation of air. The opening, however, did not interfere with the method of shading. Each chamber had a capacity of about 500 cubic decimeters.

The seeds used were from the same lot of seeds as those used in the first crop. This time, they were germinated in previously well-mixed sand in a seed box. The culture solution was prepared according to the formula that was used in Crop I, but the culture flasks were 250-cubic-centimeter Erlenmeyer. Change of solution and replacement of water lost by transpiration and otherwise were more frequent.

SERIES I. UNDER HUMID AND DRY ATMOSPHERE

Seeds germinated, July 23, 1917.
Seedlings transferred to culture flasks, July 30, 1917.
Plants placed in culture chambers, August 20, 1917.

Solutions changed, August 13, 20, and 25, and September 3, 10, and 19, 1917.
Harvested, September 22, 1917.

TABLE 12.—*Lengths of tops and roots and the number of leaves of the plants at the time of harvest.*

Plant No.	Humid.			Dry.		
	Length of top.	Length of roots.	Leaves.	Length of top.	Length of roots.	Leaves.
	cm.	*cm.*		*cm.*	*cm.*	
1	6.0	27.0	11	5.0	26.9	11
2	6.0	18.5	11	5.5	26.0	8
3	6.4	19.0	10	5.0	35.1	11
4	5.5	23.0	9	5.0	19.0	11
5	7.5	25.0	12	4.5	29.5	12
6	5.7	28.7	10	5.0	28.5	10
Average	6.2	23.5	10.5	5.0	27.5	10.5

In order to get an idea of the effect of the difference in humidity in the two culture chambers upon the relative rates of transpiration of the plants, the amount of water transpired by the individual plants for four consecutive weeks was determined by weighing plants and containers at intervals during a part of the time of the experiment. It should be stated that precautions were taken to prevent as much as possible the loss of water through other processes than transpiration or evaporation from the plants. Table 13 gives the results.

TABLE 13.—*Water transpired from August 25 to September 22.*

Plant No.	Humid.	Dry.
	g.	*g.*
1	153.6	228.0
2	144.0	220.0
3	139.0	208.0
4	132.4	209.6
5	142.0	218.0
6	154.0	263.6
Average	144.2	224.5

Tables 14 and 15 contain the results of the dry weight and ash determinations.

The data on the amount of water transpired for four weeks, the weight of total dry matter, and the percentages of total ash are combined in Table 16. In Table 17 are given the amounts of dry weight and ash per 100 cubic centimeters of water transpired.

TABLE 14.—*Absolute dry weights of parts of plants.*

Plant No.	Humid.			Dry.		
	Roots.	Stems.	Leaves.	Roots.	Stems.	Leaves.
	g.	*g.*	*g.*	*g.*	*g.*	*g.*
1	0.0980	0.0398	0.2645	0.0973	0.0428	0.3214
2	0.0980	0.0469	0.2928	0.0867	0.0360	0.2923
3	0.0912	0.0553	0.2801	0.0816	0.0393	0.2502
4	0.0881	0.0403	0.2661	0.0652	0.0359	0.1959
5	0.1052	0.0513	0.3283	0.0890	0.0356	0.2590
6	0.0994	0.0388	0.2314	0.0922	0.0366	0.2837
Average	0.0958	0.0454	0.2772	0.0853	0.0377	0.2671

TABLE 15.—*Percentage of ash in parts of plants.*

Plant No.	Humid.			Dry.		
	In roots.	In stems.	In leaves.	In roots.	In stems.	In leaves.
	P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
1	8.88	8.54	7.98	8.22	7.01	5.97
2	10.32	7.25	6.80	10.61	6.53	7.59
3	9.54	7.78	6.57	9.68	6.52	8.55
4	8.85	8.18	7.29	9.81	6.92	10.26
5	9.41	7.21	7.09	8.43	7.21	8.41
6	9.25	7.99	6.83	8.02	6.48	8.74
Average	9.38	7.83	7.09	9.13	6.78	8.25
Probable error of average	±0.14	±0.13	±0.13	±0.26	±0.08	±0.36

TABLE 16.—*Water transpired for four weeks, absolute dry weights, and the percentage of total ash.*

Plant No.	Humid.			Dry.		
	Water transpired in 4 weeks.	Dry matter.	Ash.	Water transpired in 4 weeks.	Dry matter.	Ash.
	g.		*P. ct.*	*g.*		*P. ct.*
1	153.6	0.4023	8.25	228.0	0.4615	6.54
2	144.0	0.4327	7.61	220.0	0.4150	8.13
3	139.0	0.4266	7.36	208.0	0.3711	8.58
4	132.4	0.3945	7.73	209.6	0.2970	9.76
5	142.0	0.4848	7.61	218.0	0.3836	8.31
6	154.0	0.3696	7.60	263.6	0.4125	8.38
Average	144.2	0.4184	7.69	224.5	0.3901	8.28
Probable error of mean		±0.0100	± 0.08		±0.0139	±0.26

TABLE 17.—*Proportion of dry weight and ash to 100 cubic centimeters of transpired water.*

Humid.	
Water (cc.)	100.
Dry weight (g.)	0.2901
Ash (g.)	0.0223
Dry.	
Water (cc.)	100.
Dry weight (g.)	0.1292
Ash (g.)	0.0107

SERIES II. SHADED AND UNSHADED

Seeds germinated, July 23, 1917.
Seedlings transferred to culture flasks, July 30, 1917.
Plants placed in shaded and unshaded chambers, August 20, 1917.
Solutions changed, August 13, 20, and 25, and September 3, 10, 19, and 30, 1917.
Harvested, October 2, 1917.

TABLE 18.—*Lengths of tops and roots and total number of leaves.*

Plant No.	Humid.			Dry.		
	Length of top.	Length of roots.	Leaves.	Length of top.	Length of roots.	Leaves.
	cm.	*cm.*		*cm.*	*cm.*	
1	12.0	15.5	11	3.2	21.5	12
2	10.9	14.5	11	5.5	24.5	11
3	11.5	22.5	10	4.0	24.5	10
4	11.0	19.5	11	4.8	22.3	10
5	13.0	22.5	11	4.8	24.2	10
6	10.1	25.1	10	3.2	20.5	11
7	10.0	16.5	12	3.7	16.5	12
8	9.5	18.1	10	3.9	18.5	10
9	8.5	17.0	11	4.1	19.1	11
10	6.5	19.5	19	4.6	25.3	11
11	9.8	18.1	10	3.4	20.1	10
12	10.2	20.5	10	4.8	26.5	11
Average	10.2	19.1	11.3	4.2	22.0	10.8

Tables 20, 21, and 22 contain the results of the dry weight and ash determinations; Table 23, the amounts of dry weight and ash per 100 cubic centimeters of water transpired.

DISCUSSION OF RESULTS

Transpiration.—From Tables 13 and 19 it can be seen that in both types of experiments, humid-dry and shaded-unshaded, the desired differences in conditions of relative humidity and sunlight were obtained to give a difference in the relative rates of transpiration.

TABLE 19.—*Water transpired from August 25 to September 22, 1917.*

Plant No.	Shaded.	Unshaded.
	g.	*g.*
1	161.2	230.4
2	162.8	251.6
3	172.0	278.0
4	178.0	259.6
5	180.0	270.0
6	176.4	213.0
7	147.6	222.0
8	189.6	272.0
9	136.0	276.0
10	95.2	266.0
11	138.4	240.0
12	112.0	272.4
Average	154.1	254.2

TABLE 20.—*Dry matter.*

Plant No.	Shaded.			Unshaded.		
	In roots.	In stems.	In leaves.	In roots.	In stems.	In leaves.
	g.	*g.*	*g.*	*g.*	*g.*	*g.*
1	0.0938	0.0711	0.3381	0.0700	0.0351	0.4020
2	0.0908	0.0719	0.3064	0.1473	0.0499	0.4468
3	0.0827	0.0738	0.3142	0.1684	0.0398	0.4637
4	0.0966	0.0646	0.3442	0.1637	0.0419	0.4587
5	0.1090	0.0813	0.3504	0.1934	0.0445	0.4621
6	0.0850	0.0550	0.2964	0.0845	0.0283	0.3580
7	0.0643	0.0546	0.2573	0.0994	0.0557	0.3763
8	0.0992	0.0590	0.3589	0.1579	0.0314	0.4316
9	0.0595	0.0474	0.2675	0.1362	0.0413	0.3940
10	0.0300	0.0319	0.1706	0.1438	0.0455	0.4636
11	0.0620	0.0527	0.2297	0.1324	0.0371	0.3962
12	0.0534	0.0455	0.1896	0.1580	0.0460	0.4190
Average	0.0772	0.0591	0.2853	0.1379	0.0413	0.4227

Physical characters of plants.—Considering first the crop grown in humid and dry chambers, there is found a general tendency for the roots of the "dry" plants to become longer. In Table 5 there is a difference of 11.9 centimeters and in Table 12, one of 4 centimeters in favor of the "dry" roots. In a third series this difference was insignificant, amounting to only 0.1 centimeter. There was no significant difference in the length of top and the number of leaves.

When the crop grown in shaded and unshaded chambers is considered it is seen (Table 18) that here also the roots of the unshaded plants were longer, the difference being 2.9 centi-

meters. The tops of the shaded plants averaged 6 centimeters longer than those of the unshaded. There was no important difference in the number of leaves. The leaves of those in the shaded chamber were longer, broader, thinner, and of better quality.

TABLE 21.—*Percentages of ash.*

Plant No.	Shaded.			Unshaded.		
	In roots.	In stems.	In leaves.	In roots.	In stems.	In leaves.
	P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
1	9.81	7.59	9.20	11.00	7.62	6.99
2	8.04	8.20	10.54	10.79	7.89	7.52
3	8.10	9.35	10.40	11.04	9.40	7.46
4	8.18	8.04	10.05	10.87	7.55	7.54
5	8.07	9.47	10.58	8.54	10.00	8.39
6	8.59	10.19	11.84	8.75	9.27	7.32
7	7.93	10.80	11.93	6.94	11.01	7.12
8	9.48	10.16	9.69	9.25	14.01	7.60
9	9.08	12.02	11.81	11.01	10.89	8.10
10	11.33	13.48	15.41	10.85	11.89	6.46
11	8.55	11.00	14.02	10.55	11.59	8.45
12	8.43	12.08	16.18	11.07	10.87	7.82
Average	8.80	10.20	11.80	10.06	10.17	7.56
Probable error of mean	±0.26	±0.39	±0.59	±0.35	±0.51	±0.12

TABLE 22.—*Water transpired in four weeks, absolute dry weights, and percentages of total ash.*

Plant No.	Shaded.			Unshaded.		
	Water transpired in four weeks.	Dry matter.	Ash.	Water transpired in four weeks.	Dry matter.	Ash.
	g.	*g.*	*P. ct.*	*g.*	*g.*	*P. ct.*
1	161.2	0.5030	9.10	230.4	0.5071	7.59
2	162.8	0.4691	9.72	251.6	0.6440	8.29
3	172.0	0.4707	9.83	278.0	0.6714	8.47
4	178.0	0.5054	9.43	259.6	0.6643	8.36
5	180.0	0.5407	9.35	270.3	0.7000	8.54
6	176.4	0.4364	11.02	213.0	0.4708	7.68
7	147.6	0.3762	11.08	222.0	0.5314	7.49
8	189.6	0.5171	9.70	272.0	0.6209	8.63
9	136.0	0.3744	11.21	276.0	0.5715	8.99
10	95.2	0.2325	14.62	266.0	0.6529	7.76
11	138.4	0.3444	12.57	240.0	0.5657	9.15
12	112.0	0.2885	14.11	272.4	0.6230	8.87
Average	154.1	0.4215	10.98	254.2	0.6019	8.32
Probable error of mean	----------	±0.02	±0.49	----------	±0.02	±0.15

TABLE 23.—*Proportion of dry weight and ash to 100 cubic centimeters of water transpired.*

Shaded.	
Water (cc.)	100.
Dry weight (g.)	0.2735
Ash (g.)	0.0300
Unshaded.	
Water (cc.)	100.
Dry weight (g.)	0.2367
Ash (g.)	0.0197

The single fresh-weight determination made in this study (Table 5) showed that the "dry" plants were heavier.

Dry matter.—Determinations of dry weight as well as of ash were made, not only of the entire plant, but also of roots, stems, and leaves separately in order to determine if the relative amounts of dry matter and ash vary in different parts of the plant. Information on this particular point ought to be of value in considering the merit of the data heretofore reported by different investigators for only a portion of the plant. Except in one case, analysis was of individual plants in order that the probable error due to individual variation could be determined.

Ash.—Ash is reported in the foregoing tables as percentage of dry weight, except in Tables 17 and 23. Since both the dry weight and the corresponding percentage of ash are given, the amount of ash, if desired in other cases, can be calculated very easily. In the younger crop it is seen (Table 7) that the percentage of ash in the roots and stems of the "humid" plants is greater than that in those of the "dry" ones; while in the case of leaves, the difference, though small, is in favor of the "dry" plants. As probable errors were not determined in this particular case, nothing can be said about whether or not the differences are significant. Taking the data in Table 15, which represent the percentages of ash in another, younger crop, the above comparison still holds and it is to be seen that the difference is significant for the stems. Taking the dry weight of the entire plant (Table 16) of the same crop, there was more dry matter in the "humid" than in the "dry" plants, but a slightly smaller percentage of total ash. If the total amount of ash is calculated, it will be found that in this the two crops do not differ.

In the case of the older crop in dry and humid conditions, the differences in percentages of ash in roots, stems, and leaves are all in favor of the humid plants (Table 10), but the reverse

is true in total dry matter, the difference, however, being insignificant (Table 11).

From the results with the single crop grown in shaded and unshaded chambers we find (Table 21) that the shaded plants have higher average percentages of ash in stems and leaves and lower percentages in roots than the unshaded ones. The total dry matter (Table 22) of the unshaded plants was higher, owing probably to the difference in relative rates of carbon dioxide assimilation, but in percentage of total ash the difference, which is very significant, is in favor of the shaded plants.

In Tables 16 and 22 the amount of water transpired by individual plants in the period of four weeks is placed side by side with the amount of total dry matter and percentage of total ash in each plant. Assuming that the relative amounts of water transpired in four weeks of the crops' lifetime is a fair index of the total amount of water transpired in the whole life period of the crops, the data in Tables 16 and 22, whether only for plants grown in humid or shaded atmosphere or only for those grown in dry or unshaded rooms, should furnish an indication as to whether or not the absorption of mineral salts is directly proportional to the relative rates of transpiration. In Table 16 it will be seen that in the humid crops the plant which transpired the greatest amount of water in four weeks did not have the greatest amount of dry matter or the highest percentage of ash; neither did the plant with the lowest transpiration have the lowest dry weight or percentage of ash. The same is true with the crop grown in the dry chamber. In the shaded and unshaded crop, the plants having the lowest transpiration had the least dry weights, but not the lowest percentages of ash; those with the highest amounts of transpired water again did not have the largest percentages of ash or the largest amounts of dry matter. In Tables 17 and 23 the amount of dry matter and ash corresponding to 100 cubic centimeters of water transpired are given. For 100 cubic centimeters of transpired water we see that the "humid" or "shaded" plants average higher in absolute weight of ash and dry matter.

CONCLUSION

The results of the present experiments show that in tobacco plants grown in water culture, there was no absolute correlation between the percentage of ash, the relative rates of transpiration, and the total dry matter.

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SAPINDACEAE NOVAE PHILIPPINENSES

Auctore L. RADLKOFER

LEPISANTHES ACUTISSIMA Radlk. sp. nov.

Frutex mediocris, glaber, cauliflorus; trunci ramique flavescenti-cani, teretes, lenticelloso-punctati; folia paripinnata, 2- vel 3-juga, petiolo tereti elongato striato; foliola lanceolato-oblonga, in acumen elongatum acutissimun sensim attenuata, basi inaequaliter obtusata (latere exteriore paullulo latiore longioreque) petiolulis breviusculis subcylindricis hirtellis insidentia, chartacea, nervis lateralibus remotiusculis procurvis, flavoviridia, utrinque opaca, praeter nervum medianum subtus pilis brevibus laxe adspersum glabra, glandulis praesertim supra profunde immersis ornata, epidermide paginae inferioris sparsim (plerumque in cellulis geminatis) crystallorum concretiones parvas gerente; thyrsi ad trunci basin (10 cm supra solum) pauci fasciculati, breviusculi, dense cincinnigeri; flores mediocres; sepala flavide tomentosa, intus glabra; petala 5, lanceolata, unguiculata, dorso praeter marginem sericeo-tomentosa, intus glabra et supra unguem squama brevi biloba deflexa glabriuscula aucta; discus regularis, tomentellus; stamina 8, apice pilosa, antherae glabriusculae; germen trigono-ovatum, triloculare, dense flavo-tomentosum, in stylum apice glabrum attenuatum, loculis intus infra gemmularum insertiones dense pilosis; fructus (non suppetebat).

Frutex 1–2 m altus, truncis digitum crassis. Rami foliati 4–5 mm crassi. Folia petiolo 10–12 cm longo adjecto ad 45 cm longa; foliola superiora cum petiolulis 5 mm longis ad 30 cm longa, 8.5 cm lata, inferiora fere dimidio minora. Thyrsi 4 cm longi. Flores 5 mm longi, albi.

In Philippinarum insula Palawan: *Merrill n. 9564!* (ad lacum Manguao, alt. 80 m, m. Mai 1913, fl.; comm. ex Hb. Manil.).

Obs. Inter species floribus regularibus germineque 3-loculari praeditas excellens inflorescentiis ad trunci basin erumpentibus discoque tomentello.

LEPISANTHES MACROCARPA Radlk. sp. nov.

Frutex mediocris; folia paripinnata, 4-juga, petiolo tereti breviter sufferrugineo-tomentoso; foliola inferiora ovata, supe-

riora plus duplo majora elliptica, omnia acuta, basi obtusa petiolulis longiusculis tumidis tomentosis insidentia, integerrima, chartacea, nervis lateralibus approximatis obliquis subtus prominentibus, supra praeter nervum medianum hirtellum glabra, laeviuscula, pallide viridia, subtus pilis subulatis patulis hirta, utrinque glandulis profunde immersis ornata; flores (non suppetebant); fructus major, bilocularis, e transversim ellipsoideo subcylindraceus, inter loculos sulco levi, septi margini respondenti exaratus, inde subbicoccus, basi sepalorum reliquiis tomentosis suffultus, apice subapiculatus, pericarpio corticoso-coriaceo tomento hirto fusce ochraceo obducto, dein ± glabrato, mesocarpio e concretionibus sclerenchymaticis conflato, endocarpio membranaceo tenuissime fibroso non solubili pilis paucis subsetaceis e pede fusiformi inter endocarpii fibros superficiales interjecto emergentibus adsperso; semen globosum, ad loculi basin septo affixum, testa tenuiter coriacea laevi brunnea; embryo erectus, obsolete notorrhizus, cotyledonibus hemisphaericis oblique juxtapositis farinaceo-carnosis albidis, radicula brevi micropylen versus curvata.

Frutex ca. 1-metralis. Folia petiolo 10 cm longo adjecto 60 cm longa; foliola inferiora cum petiolulis 1 cm longis 13 cm longa, 6 cm lata, superiora 30 cm longa, 12 cm lata. Fructus 4–4.5 cm latus, 2 cm altus et crassus. Semen diametro 1.5 cm.

In Philippinarum insula Luzon: *M. Ramos n. 19460!* (prov. Tayabas, in monte Pular, m. Jan. 1913, fr.; comm. ex Hb. Manil.).

Obs. Affinis Lepisanthi eriolepidi Radlk., a qua differt foliolis acutis, fructu majore, endocarpio non solubili.

HEDYACHRAS Radlk. (gen. nov.) in Engl. Bot. Jahrb. 56 (1920) 258, annot: (charact. brevis)

Flores minores, spurie polygami, masculi numerosi et feminei (hermaphroditos mentientes) pauci in iisdem inflorescentiis. Calyx 4-sectus, segmentis deltoideis subinduplicato-valvatis, denique horizontaliter expansis, immo reflexis, extus subfulvo-tomentosis, intus cano-pubescentibus, pressione staminum et antherarum striatis. Petala 0. Discus fundum calycis vestiens, patellaris, glaber, margine crenulatus nigro-fuscus. Stamina (an semper ?) 6, (floris ♀ brevia) filiformia, intra discum inserta glabra, in alabastro supra discum arcuatim expansa, apice inflexa (inde bis curvata), dein exserta; antherae tumide deltoideae, apice retusae, basi excisae, dorso supra excisuram affixae, introrsae, connectivo dorso dilatato, glabrae, in alabastro arcte conniventes; pollinis granula trigono-globosa triporosa,

parva. Germen (floris ♂ rudimentarium) in disci centro sessile, tumide obcordatum, 2-loculare, inter loculos sulco exaratum, densissime tomentosum, stylo brevissimo conico sulco suturali notato sub tomento ± occulto superatum. Gemmulae, in loculis solitariae, axeos tuberculo basali insidentes, erectae sub-campylotropae, micropyle extrorsum infera. Fructus magnus carnosus indehiscens, compressiuscule pyriformis pyrique mediocris magnitudine, ± glabratus, fragrans, edulis, sapore grato (inde generis nomen), 2- vel abortu 1-spermus. Semen oliviforme exarillatum, testa tenuiter crustacea, endocarpio e cellularum filiforminum collenchymaticarum stratis decem pluribusve conflato arcte adhaerente spadicea glabra. Embryo erectus, parum curvatus; cotyledones crassae, carnoso-farinosae, ± conferruminatae, siccae induratae, inaequales, oblique superpositae, dorsali (superiore) majore apice crassiore intus concavo, ventrali (an semper ?) minore basi crassiore biconvexa, plano commissurali inde in directione longitudinali et transversali curvato; radicula ad seminis basin perparva papilliformis.

Arbor sat alta. Rami teretes, striati, tomento isabellino vestiti, lenticellis linearibus seriatis notati. Folia abrupte pinnata, 4- ad 6-juga, sat petiolata, exstipulata; foliola majuscula, inferiora ovata, superiora longiora ex oblongo lanceolata utrinque acuta vix acuminata, petiolulis brevibus a dorso complanatis basi dilatatis suffulta, integerrima, subundulata, chartacea, nervis lateralibus utrinque ca. 12 obliquis margine sursum versis et ± anastomosantibus subtus magis quam supra prominentibus, praeter nervum medianum puberulum glabra, subtus in axillis nervorum barbulata, glandulis microscopicis longiusculis fugacibus utrinque adspersa, supra livescenti-viridia nitidula, subtus flavescenti-viridia, impunctata, cellulis secretoriis nullis, diachymate e cellulis staurenchymaticis superioribus longioribus inferioribus sensim brevioribus conflato, epidermide non mucigera; petiolus rhachisque supra costa mediana obtusa notata glabriuscula, subtus convexa striata pube molli sordida adspersa. Panicula in ramulis foliatis terminalis, robusta folia vicina aequans vel paullo superans, a basi divaricatim ramosa, subferrugineo-tomentella, ramis thyrsoideis elongatis (arcus parte convexa plerumque sursum versa) fere a basi rhachique superne dichasiis breviter stipitatis in cincinnos abeuntibus compacte multifloris inferioribus approximatis superioribus in verticillos quodammodo distantes congestis dense obsitis; bracteae bracteolaeque ovato-lanceolatae, tomentellae. Alabastra globosa, seminis Brassicae Rapae magnitudine, cum pedicellis brevibus

pube brevi densissima crispula sordide fulva induta, pedicellis prope basin articulatis cicatrices fuscas pube canescente cinctas arcte congestas relinquentibus.

Obs. Genus ob fructum indehiscentem subintegrum et semen exarillatum Tribui Melicoccearum adsciendum videtur, generibus "Castanospora" et "Tristira" accedens, cum ulteriore floribus apetalis conveniens.

HEDYACHRAS PHILIPPINENSIS Radlk. l. c. (nomen) sp. nov. Character ut supra.

Arbor 15–18 m alta, trunco 30–33 cm diametro. Folia petiolo 9 cm longo adjecto ca. 40 cm longa, superiora paniculae vicina fere dimidio minora; foliola cum petiolulis 5 mm longis ad 18 cm longa, 6.5–7 cm lata, infima summaque minora, 9–12 cm longa, 5–6.5 cm lata. Panicula ad 22 cm longa, ramis inferioribus 18 cm longis. Flores diametro 5 mm. Pedicelli 2–4 mm, fructigeri 1.3 cm longi. Sepala 2 mm longa, 1.5 mm lata. Stamina 3 mm longa. Fructus (siccus) 6 cm longus, 4.5–5.5 cm crassus. Semen 3 cm longum, 2–2.3 cm crassum.

In Philippinarum insula Luzon: *A. Villamil n. 20635!* (prov. Laguna, ad montem Maquiling, secundum flumen Molauin, in campo instituti agronomici, alt. 30 m, m. Nov. 1914, fruct.; comm. ex Hb. Manil.).

EUPHORIANTHUS OBTUSATUS Radlk. in lit. ad S. H. Koorders (1897), nomine a Koorders edito in Fl. Minahassae, Meded. Plantent. 19 (1898) 406; Radlk. in Engl. & Pr. Nat. Pfl.-Fam. Nachtr. III, Ergänz.-Heft II (1907) 206 (character brevis); Koord.-Schum. Syst. Verz. 3 Celebes (1914) 75, coll. *18819 β. 18848 β*;-Sapindac. spec. Koord.-Schum. l. c. 76, coll. *18839 β*;-E. sp. Koorders l. c. p. 222. Vulgo "Woesel" sive "Tompinis-in-taloen" in lingua Tontemboan; "Boesel-in-Koko," sive "Woesel-in-Koko," in lingua Toelooer in Celebes t. Koord. l. c. sub. E. obtus.; "Soesoei" in insulae Celebes districtu Tonsavang t. Koord. l. c. sub E. sp.

Arbor; rami teretiusculi, sulcati petiolique ochraceo-tomentelli; folia abrupte pinnata; foliola 10–16 alterna, oblonga, obtusa, basi subcuneata, longius breviusve petiolulata, submembranacea, multinervia, nervis utrinque 15–20 obliquis subtus prominentibus, praeter nervos utrinque puberulos glabriuscula nec nisi glandulis breviter vermicularibus adspersa, utrinque laevia, nitidula, pallide viridia, cellulis secretoriis instructa; paniculae ad apices ramorum axillares, folia subaequantes; flores fructusque generis.

Rami 5–6 mm crassi. Folia petiolo 6–8 cm longo adjecto 30–40 cm longa; foliola cum petiolulis 5–10 mm longis ad 16 cm

longa, 4.5 cm lata. Paniculae 24–30 cm longae, ramis 5–10 cm longis; bracteae bracteolaeque lanceolatae, tomentellae; pedicelli 1.5 cm longi, supra medium articulati. Capsula diametro 2 cm.

In Celebes et Philippinis: *Koorders 18819 β!* (Celebes prov. Minahassa m. Apr. 1895, fl.; Hb. Bog. et ex hoc commc. Hb. Monac.), *18839 β!* (ibid. fr.), *18848 β* (ibid. ex Koord.-Schum. l. c.); *D. P. Miranda 18274!* (in Philippinarum insula Mindanao, distr. Cotabato, m. Mai-Jun. 1912, fl; comm. ex Hb. Manil.).

Obs. Valde affinis E. longifolio (Roxb.) Radlk. speciei celebico-moluccano-papuasicae, quae differt foliolis acutis, chartaceis, subtus opacis.

TRIGONACHRAS FALCATOCUSPIDATA Radlk. sp. nov.

Arbor; rami teretes, glabri, nigro-fusci, foliola abrupte pinnata, petiolo rhachique teretiusculis glabris, foliola 6–8, opposita, breviuscule ovato-lanceolata, parum inaequilatera, apice abruptius in acumen acutum falcatum attenuata, longiuscule petiolulata, rigidiuscule coriacea, nervis lateralibus subtilibus procurvis retique venarum supra prominulis, glabra, supra nitida, subtus opaca et interdum basi glandulis maculiformibus paucis notata, saturate, viridia, crebre pellucido-punctata, epidermide mucigera; paniculae thyrsive ad apicem ramorum axillares, folia superantes, dichasia pluriflora vel apice cincinnos gerentes, rhachi ramisque pedicellisque subferrugineo-pulverulento-puberulis; flores generis sat pedicellati; capsula magna, trigono-clavata obtusa, glabra, (sicca) rubro-spadicea, intus tomentoso alutaceo vestita; semen infra medium loculum affixum, ellipsoideum, testa coriaceo-crustacea spadicea laevi exarillata.

Rami 4 mm crassi. Folia petiolo 3–4 cm longo adjecto ca. 18 cm longa; foliola cum petiolulis 6–8 mm longis 8–10 cm longa, 2.2–3.4 cm lata. Paniculae ad 20 mm longae. Pedicelli 2–3 mm, fructigeri 5–6 mm longi. Flores 3 mm alti et lati. Calycis segmenta late ovata puberula, intus glabra; petala ex elliptico subrhombea, in unguem denique aequilongum attenuata, calycem subduplo superantia, 3 mm longa, intus supra unguem squamulis 2 cuneatis cristatis aucta, basi margine ut et unguis squamulaeque dense villosa, albida, pellucido-punctata; discus crassiuscule annularis, glaber; stamina pilosa longius exserta, 5 mm longa, antheris clavatis glabriusculis; germen (fl. ♂) rudimentarium trigono-globosum, puberulum. Capsula 4–5 cm longa, 2.5–3 cm lata. Semen 1.2 cm longum, 7 mm crassum.

In Philippinarum insula Luzon. *M. Ramos 20467;* (San Antonio, prov. Laguna, m. Febr. 1913, fl.), *14920;* (ibidem, m. Jun. 1912, fr.; comm. ex Hb. Manil.).

Obs. Fructus indole accedit ad T. cuspidatum, foliorum indole ad T. rigidam.

MISCHOCARPUS SUBLAEVIS Radlk. sp. nov.

Rami teretiusculi, verruculoso-lenticellosi, glabri; folia abrupte pinnata, petiolo rhachique striatis; foliola ca. 6, opposita, oblongo-lanceolata, utrinque acuta, petiolulata, integerrima, coriacea, nervis lateralibus sat approximatis patentibus, reti venarum angusto utrinque vix prominulo, inde subtus quoque sublaevia et nitidula, obsolete pellucido-punctata, efoveolata; paniculae subterminales pauciramosae, quam folia breviores, adpresse puberulae; flores longius pedicellati, apetali, calyx et discus laxe, stamina et germen densius puberula; discus annularis, dein dilatatus, circumcirciter declinatus, pluricostatus, inter costas sulcis latiusculis exaratus; fructus (non suppetebat).

Rami 8 mm crassi. Folia petiolo 8 cm longo adjecto ad 40 cm longa; foliola cum petiolulis 1 cm longis ad 20 cm longa, 7.5 cm lata. Paniculae 25 cm longae; pedicelli 3–4 mm longi prope basin articulati; bracteae perparvae. Flores expansi vix 2 mm lati.

In Philippinarum insula Leyte: *C. A. Wenzel 600!* (m. Mai-Jul. 1914; comm. ex Hb. Manil.).

Obs. Affinis M. sundaico Bl., qui differt foliolis subtus reti venarum angustissimo prominulo eleganter notatis, plurifoveolatis, nec non disco anguste annulari glabro.

OBSERVATIONS ON THE LIFE HISTORY OF ASCARIS VITOLORUM, A PARASITE OF BOVINES IN THE PHILIPPINE ISLANDS

PRELIMINARY PAPER

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ONE PLATE

INTRODUCTION

The occurrence of *Ascaris vitolorum* in cattle and water buffaloes in the Philippine Islands and the importance of the parasites as serious pathogenic agents have already been emphasized by me.(3) Since the preparation of that paper, studies on the eggs and larvæ of these parasites have led to certain conclusions concerning the effect of sunshine on the embryonated eggs and on the invasion by the larvæ of various organs that are of sufficient importance to warrant their publication at this time. Observations on the development of the eggs are also included.

DEVELOPMENT OF EGGS

The eggs of *Ascaris vitolorum* vary considerably in shape and in size, as shown in Plate 1, figs. 1 to 10. Measurements of about seventy eggs showed a maximum length of 99 μ, a minimum length of 68 μ, a maximum width of 76 μ, and a minimum width of 65 μ. Most of the eggs measured varied from 76 to 84 μ in length and from 64 to 68 μ in width. The majority of the eggs studied were more or less elliptical, although a small percentage of those that have come under my observation were almost spherical.

Under the influence of climatic conditions prevailing in the Philippines in December, January, and February, during which time the approximate average temperature was about 25° C., the eggs, which are unsegmented when expelled from the host, segment rapidly, and within five or six days the outline of the embryo can be distinguished in cultures of eggs kept in Petri

dishes containing a thin layer of 2 per cent formalin (Plate 1, figs. 9 and 10). Formalin cultures ten to twelve days old contain embryonated eggs (Plate 1, figs. 11 and 12), the embryos generally exhibiting sluggish movements.

In common with the behavior of embryonated eggs of other species of *Ascaris*, further development does not take place unless the eggs are swallowed by a suitable host. Occasionally, dead larvæ have been observed in culture dishes, but hatching outside of the host is an unusual occurrence.

The vitality of the eggs of *Ascaris vitolorum* was considerably reduced after two months, during which time they were kept in 2 per cent formalin at room temperature. Although many eggs still showed vitality in response to heat stimulation, they produced very light infestations in experimental animals to which they were fed. Examination of fæces from such experimental animals, two or three days after artificial infection, revealed the presence of numerous embryonated eggs, apparently dead. Whether the eggs normally have a short duration of life or whether the growth of fungi in culture dishes is a factor in shortening their life has not been determined.

Experimental feeding of ripe eggs to rats and guinea pigs resulted in the hatching of viable eggs and the elimination of the eggshells and of undeveloped eggs with the fæces. Empty eggshells eliminated with the dejecta of the alimentary canal were invariably broken (Plate 1, fig. 14), thus proving that the hatching of the eggs is the result of the activity of the embryos, whose escape from the shell involves the rupture of the latter. Undeveloped eggs passed through the alimentary canal intact (Plate 1, fig. 13).

Eggs of *Ascaris vitolorum* do not hatch in the stomach, as the following observations will show. Within two hours after forced feeding of eggs to guinea pigs, numerous unhatched eggs were found in the stomach, hatched and unhatched eggs as well as larvæ were found in the small intestine, whereas most eggs that were found in the large intestine and cæca were undeveloped.

That hatching of eggs is due to the activity of the embryos rather than to the passive effects of the intestinal environment is further shown by the results of feeding to experimental animals old cultures of embryonated eggs many of which were nonviable. After artificial infection with these eggs large numbers of dead embryonated eggs were found in the fæces of ex-

perimental animals, whereas after feeding fully virulent eggs the fæces of the host animal seldom contained embryonated eggs.

Exposure of eggs to tropical sunlight in order to determine the effects of light and heat on the viability of the embryos resulted in the hatching of a number of eggs, as evidenced by the finding of free larvæ and empty eggshells after exposure. Since embryos inclosed in eggshells are stimulated to increased activity under the influence of heat, it may be concluded that the excessive activities to which they were subjected during the exposure resulted in their liberation from the shells.

EFFECTS OF DRYING AND OF TROPICAL SUNSHINE ON EMBRYONATED EGGS

The eggs of *Ascaris vitolorum* are resistant to drying. Eggs were allowed to dry on slides that were kept in shaded places for various periods ranging from several hours to several days, and after being moistened with water they frequently resumed their sluggish movements without further stimulation. In cases in which the embryos showed no movements after being moistened, they were readily stimulated to activity by heat. Eggs similarly exposed on slides to the influence of the sun's rays did not recover after an exposure of one hour. Microscopic examination showed these eggs to be paler than normal eggs and also revealed evidence of internal disorganization of the larvæ.

Further studies on the effects of sunshine on embryonated eggs were made by exposing beakers containing them to sunlight for various periods. The minimum exposure of one hour was invariably destructive to eggs on bright days. After exposure, the eggs were examined under a cover glass. They were not only pale in appearance, but also showed profound internal disorganization and vacuolization, the outline of the embryos being rather hazy and the contents opaque.

In order to determine the effects of light and heat separately, several lots of eggs were exposed in vials, some of which were painted black with India ink, thus shutting out light. A one-hour exposure proved fatal in both blackened and unblackened vials, thus showing that the exclusion of light did not diminish the lethal action of heat.

The vials and beakers used in these experiments were placed on the ground outside of the laboratory, and a thermometer was placed close to the glass containers. The thermometer usually registered 45° C.

It is highly probable that sunshine is responsible for the destruction of eggs of *Ascaris vitòlorum* in soil. Sunshine, because of its destructive action on the eggs and larvæ of helminths, is probably an effective natural weapon against depredations of internal parasites. Exposure to sunshine of manure infested with ova and larvæ of helminths may prove effective, at least in the Tropics, in rendering it innocuous so far as concerns parasites.

COMPARATIVE VIRULENCE OF ASCARIS VITOLORUM FOR GUINEA PIGS

Experiments involving forced feeding of embryonated eggs to guinea pigs and rats showed that the effects produced on these animals were generally milder than those produced by the larvæ of *Ascaris lumbricoides*. As a matter of fact, negative post-mortem results were obtained in several cases in which moderate doses of eggs were fed. Extremely heavy doses of eggs fed to guinea pigs produced symptoms of *Ascaris* pneumonia, but deaths were not common. While I know of no accurate method by which to judge the relative effects of eggs of *Ascaris lumbricoides* and *A. vitolorum* on guinea pigs, I have reason to believe, basing my belief on results from experimental feeding of eggs of both species to these animals, that they are more resistant to the larvæ of *A. vitolorum* than they are to those of *A. lumbricoides*, so far as can be judged by recovery following an attack of *Ascaris* pneumonia.

OCCURRENCE OF LARVÆ IN VARIOUS ORGANS

Observation on the invasion of the lungs and liver by the larvæ of *Ascaris vitolorum* revealed nothing that differs essentially from the invasion of these organs by the larvæ of *A. lumbricoides*, except that the liver remained parasitized for longer periods in animals infected with the former species.

Larvæ were not found in the blood, which probably was due to the fact that the experimental animals that were examined within a day or two after artificial infection generally proved to be lightly parasitized. This was due in turn to the feeding of old cultures that contained many nonviable embryonated eggs. Larvæ were found in the liver as early as one day after artificial infection, but the lungs and other organs were negative in this early stage of infection.

As has been mentioned the most-striking difference in behavior of the larvæ of *Ascaris vitolorum* and of *A. lumbricoides* is the comparatively longer sojourn of the former in the liver. In a recent paper on the course of migration of *A. lumbricoides*

larvæ, by Ransom and Cram,(2) the following statement with reference to the sojourn of larvæ in the liver occurs:

> After the fifth day they are usually so scarce as to be found with difficulty and often none are found even after repeated examination. In the present series of experiments no larvae were found in the liver later than seven days after infection.

Ransom and Cram examined the livers of sixty-eight animals, of which fourteen were examined later than seven days after feeding the eggs. In five cases in which the duration of infection was seven days, only one liver was positive, the infection being light. In fourteen cases in which the duration of the infection was from eight to twelve days, the livers were all negative. I have found the liver of guinea pigs heavily infested with larvæ five days after artificial infection, whereas Ransom and Cram found larvæ in the liver of four out of five guinea pigs during a similar stage of infection, but the larvæ were not numerous. I have found numerous larvæ in the liver of guinea pigs nine days after feeding eggs, and in one case I found the liver heavily parasitized by larvæ thirteen days after feeding eggs. In the last case numerous press preparations of the lungs were made, but no larvæ were found despite the fact that these organs still showed numerous petechial hæmorrhages characterestic of *Ascaris* pneumonia. Guinea pigs examined nine days after feeding eggs usually contained more larvæ in the liver than in the lungs, so far as could be judged by the relative abundance of the parasites in these organs as seen in press preparations.

It appears evident, therefore, that the larvæ of *Ascaris vitolorum* sojourn in the liver of guinea pigs for a relatively long time. The fact that they are still abundant in the liver after the lungs have become free from them indicates that larvæ of *A. vitolorum* are arrested in the liver in heavy experimental infections, and that many of these larvæ probably fail to reach the lungs. Further studies on this phase of bovine ascariasis in experimental animals are in progress.

In heavy experimental infections larvæ were also found in the spleen, pancreas, kidneys, and heart cavity nine days after infection. The kidneys were heavily infested, and larvæ were found in the cortical as well as in the medullary portions. The presence of larvæ of *Ascaris lumbricoides* in the kidneys was overlooked in the earlier studies on the migrations of the larvæ. Yoshida(4) and Fülleborn(1) found them in these organs.

The guinea pig whose liver was heavily infested thirteen days after feeding eggs failed to show larvæ in the lungs, kidneys, spleen, pancreas, blood vessels, and spinal fluid.

SUMMARY

The observations recorded in this paper may be summarized as follows:

1. Eggs of *Ascaris vitolorum* were observed to develop rapidly under the influence of tropical conditions, and many contained embryos in about ten to twelve days.

2. Ingestion of embryonated eggs by experimental animals resulted in the hatching of the embryos in the intestine and the elimination of undeveloped eggs and of dead embryonated eggs with the dejecta from the alimentary canal.

3. Hatching is apparently the result of the activities of the larvæ under the stimulus of body temperature and probably also of the general intestinal environment.

4. The eggs of *Ascaris vitolorum* can withstand drying if they are protected from the direct rays of the sun. Dry and moist eggs are rapidly destroyed by tropical sunlight, the destructive action being independent of the light rays. The temperature under which these experiments were carried out was 45° C.

5. The larvæ of *Ascaris vitolorum* were found to linger in the liver of guinea pigs for longer periods than the larvæ of *A. lumbricoides* and were still present in the liver after the lungs had become free from parasites. This appears to indicate an arrest of larvæ in that organ.

6. In heavy experimental infections other organs besides the lungs and liver, notably the kidneys, were heavily invaded by larvæ.

7. Guinea pigs appear to be more resistant to the effects of the invasion of the lungs by larvæ of *A. vitolorum* than they are to the effects of a similar invasion by larvæ of *A. lumbricoides*.

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ILLUSTRATION

PLATE 1

FIGS. 1 to 10. Eggs of *Ascaris vitolorum* in different stages of development, showing variations in shape and size.

11 and 12. Embryonated eggs of *Ascaris vitolorum*.

FIG. 13. Undeveloped egg of *Ascaris vitolorum* from fæces of rat twenty-four hours after artificial infection.

14. Empty eggshell of *Ascaris vitolorum* from fæces of rat twenty-four hours after artificial infection.

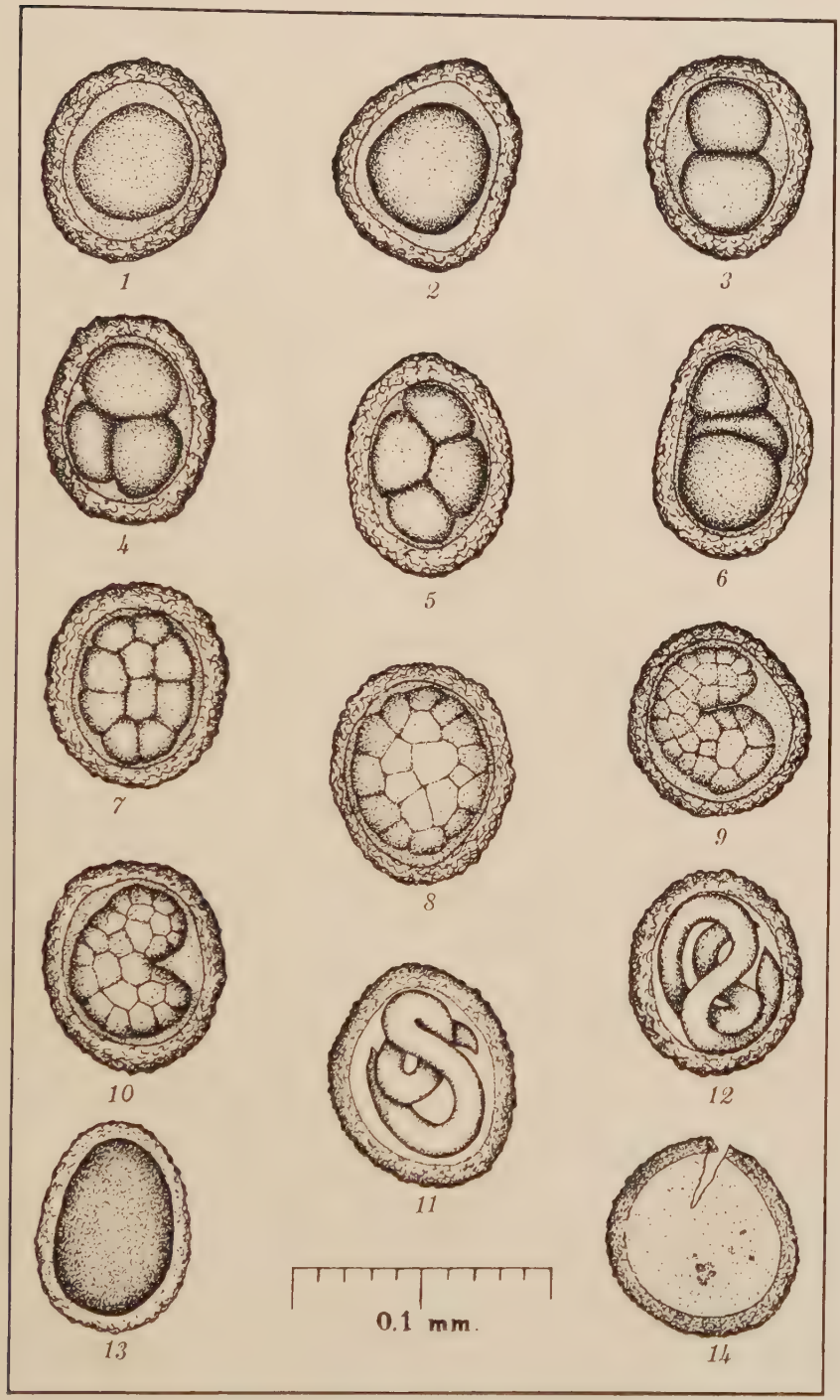

PLATE 1. EGGS OF ASCARIS VITOLORUM.

ERRATA

Volume 19, page 481, line 25, *for* iripïdes *read* iridipes.
Page 528, line 19, *for* annalis *read* annatis.
Volume 20, page 276, line 24, *for* Poeciloterpa *read* Poeciloptera.

INDEX

[New generic and specific names and new combinations are printed in clarendon; synonyms and names of species incidentally mentioned in the text are printed in *italic*.]

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